VOLUME 63 WINTER 1960 NUMBER 4

THE BRYOLOGIST

Quarterly Journal of the American Bryological Society

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THE BRYOLOGIST.—A quarterly journal devoted to the study of North American mosses, hepatics, and lichens, published by the American Bryological Society. **Subscription price, in the United States, $5.00 per year, net; in all other countries, $5.15.**

Back volumes of THE BRYOLOGIST are available from Dr. Lewis E. Anderson, Department of Botany, Duke University, Durham, N. C.; or the Secretary-Treasurer, at the following prices: volumes 1-4, $1.25 each; volumes 5-36, $2.50 each (60 cents per individual number); volume 37, $3.00; volumes 38-45, $3.50 each (85 cents per individual number); volumes 46-49, $4.00 each; volume 50, $8.00; volumes 51-56, $6.00 each ($2.00 per individual number).

PUBLICATION OFFICE: Seeman Printery, Durham, N. C.

Address manuscripts to the Editor:

DR. HOWARD A. CRUM, National Museum of Canada, Ottawa, Ontario, Canada.

Manuscripts should be typewritten, double-spaced, on 8½ by 11 inch sheets. Only first copies (not carbons) should be submitted. Reprints of articles will be supplied at a reasonable price if ordered when corrected galley proof is returned.

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THE BRYOLOGIST

JOURNAL OF

THE AMERICAN BRYOLOGICAL SOCIETY

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STUDIES ON THE GROWTH OF HAPLOMITRIUM. II. MEDIA CONTAINING AMINO ACIDS

KRISHAN KANTA SHARMA, VIOLET M. DILLER, and MARGARET FULFORD[1]

An earlier experiment (Fulford & Diller, 1956) on the growth of *Haplomitrium hookeri* (Lyell) Nees in organic media indicated that the inclusion of glucose and tryptone resulted in the development of large tufts of robust plants. These data led to the question of which of the amino acids present in the peptone might be most important in contributing to the good growth. Therefore, the present experiment was designed to compare the growth upon (1) a basal medium of inorganic salts and glucose, with growth in media to which either (2) tryptone, (3) casein hydrolysate, (4) diamino acids, (5) aromatic amino acids, (6) sulfur-containing amino acids, (7) β-hydroxy amino acids, (8) the leucines, (9) dicarboxylic amino acids, (10) glycine and alanine, or (11) cyclic imino acids had been added.

MATERIALS AND METHODS

The basal medium contained 0.2 gm. NH_4NO_3, 0.1 gm. $CaCl_3$, 0.1 gm. KH_2PO_4, 0.1 gm. $MgSO_4 \cdot 7H_2O$, 5 mg. $FeCl_3 \cdot 6H_2O$, and 5.0 gm. anhydrous glucose per liter.

Amino acid solutions were prepared as follows:

l (±) arginine monohydrochloride	20.5 mg./25 ml.
l (±) histidine monohydrochloride	12.5 mg./25 ml.
l (±) lysine monohydrochloride	27.6 mg./20 ml.
l (−) tyrosine	25.6 mg./ 20 ml.
l (−) tryptophane	9.0 mg./25 ml.
dl-phenylalanine	41.6 mg./20 ml.

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l-cystine	7.2 mg./200 ml.
dl-methionine	28.0 mg./20 ml.
dl-threonine	31.2 mg./20 ml.
dl-serine	60.0 mg./20 ml.
dl-leucine	97.8 mg./20 ml.
dl-isoleucine	52.0 mg./20 ml.
dl-valine	56.0 mg./20 ml.
l (+) glutamic acid	114.0 mg./25 ml.
dl-aspartic acid	50.4 mg./20 ml.
glycine	10.0 mg./100 ml.
β-alanine	22.4 mg./20 ml.
l (−) proline	32.8 mg./20 ml.
l (−) hydroxyproline	10.0 mg./25 ml.

The above concentrations are such that 20 ml. of each of the amino acid solutions per liter of final medium will result in a composition of amino acids comparable to 0.04% concentration of casein (Block & Bolling, 1945, p. 303).

The inorganic salt-glucose medium was prepared double strength. The various solutions and materials were added together to formulate the different media in the following manner:

No. 1. Basal medium: inorganic salts-glucose.

No. 2. 500 ml. basal medium (double strength) and 0.4 gm. tryptone (Difco Laboratories) per liter.

No. 3. 500 ml. basal medium (double strength) and 4 ml. casein hydrolysate ("vitamin-free," 10% solution, General Biochemicals, Inc.) per liter.

No. 4. 500 ml. basal medium (double strength), 20 ml. arginine solution, 20 ml. histidine solution, and 20 ml. lysine solution per liter.

No. 5. 500 ml. basal medium (double strength), 20 ml. tyrosine solution, 20 ml. tryptophane solution, and 20 ml. phenylalanine solution per liter.

No. 6. 500 ml. basal medium (double strength), 40 ml. cystine solution, and 20 ml. methionine solution per liter.

No. 7. 500 ml. basal medium (double strength), 20 ml. threonine solution, and 20 ml. serine solution per liter.

No. 8. 500 ml. basal medium (double strength), 20 ml. leucine solution, 20 ml. isoleucine solution, and 20 ml. valine solution per liter.

No. 9. 600 ml. basal medium (double strength), 20 ml. glutamic acid solution, and 20 ml. asparatic acid solution per liter.

No. 10. 500 ml. basal medium (double strength), 20 ml. glycine solution, and 20 ml. alanine solution per liter.

No. 11. 500 ml. basal medium (double strength), 20 ml. proline solution, and 20 ml. hydroxyproline solution per liter.

The pH of all media was adjusted to 6.5 before autoclaving.

Although the concentrations of the amino acids in media nos. 4-11 were chosen to compare with their concentrations as obtained by use of 0.04% tryptone (medium no. 2) and 0.04% casein hydrolysate (medium no. 3), it should be kept in mind

that the total concentration of organic nitrogen compounds would in all cases be less, since only two or three of the amino acids are used in media nos. 4-11.

For each type of medium, two 500 ml. Erlenmeyer flasks containing 250 ml. of liquid medium each were prepared. Gauze-wrapped cotton plugs were used, and the whole was sterilized at a pressure of 15 lb. for 30 min. Inoculations were made with a wire loop; and a small portion of a tuft, two or three stems, was transferred from stock agar slant cultures of the same clone previously used (Fulford & Diller, 1956). The flasks were kept in a cabinet (Diller, Fulford, & Kersten, 1955) with illumination of approximately 200 f.c. on a 20-hour light: 4-hour dark cycle each day, at a temperature of 16°C. The plants were grown for 16 weeks and were then examined; drawings were made of structures of special interest. They were then air-dried on filter paper for four days before they were weighed.

The plants of the stock cultures were rather long, with distant leaves and underleaves (Fig. 1). The leaves were nearly twice as long as broad and did not show any indication of the development of the sac-like structures in which young rhizomes are formed. There were few branches on the rhizomes and no indication of rhizome formation on a stem between the leaves.

Results

The differences between the various cultures became marked by the end of seven weeks. The colonies in some of the media made excellent growth; some made little or no growth and died within a few weeks; three soon became contaminated and were thrown out; and several, after good growth for a time, lost their green color and died a short time before the end of the 16-week period. The brief report of growth and development of the plants in each culture medium follows.

No. 1. The colonies in the basal medium developed slowly for 14 weeks, then rapidly became much larger. After 16 weeks they were bright green and 0.8 cm. and 1 cm. in diameter. On examination, the plants showed an extreme development of short rhizome-like branches along the stem between the leaves or in place of leaves (Fig. 2, R). The leaves were, in part, irregular in outline, with many slime papillae along the margin, as in the usual condition in this genus (Fig. 3,4).

No. 2. The colonies grew slowly until the tenth week when they became vigorous and bright green. At the end of 16 weeks there were seven spherical masses from 1.5 to 2.3 cm. across.

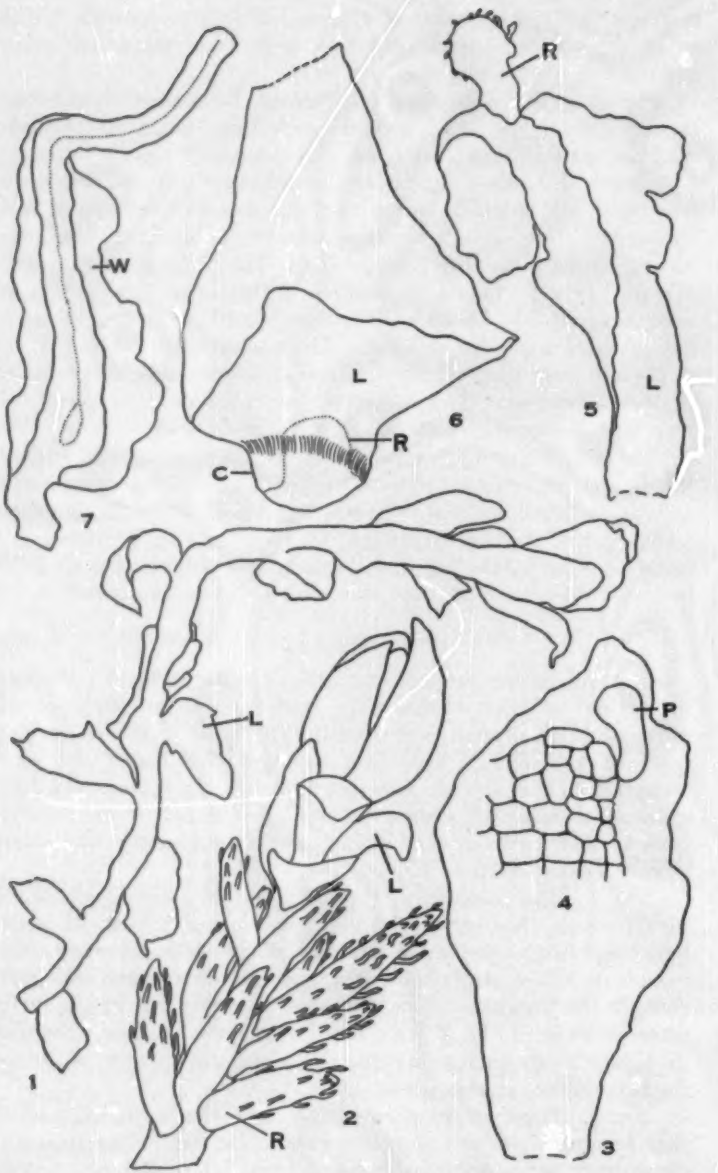

FIG. 1-7. *Haplomitrium hookeri.* 1. A plant from the stock culture, L,

The rhizomes branched freely, and similar rhizome-like branches were abundant from the stems between the well-formed leaves. In one flask, some of the leaves had developed pouches (FIG. 5,6) similar to those described earlier (Fulford & Diller, 1956, fig. 22-24). In that study, however, the leaf-pouches were formed only on those plants growing on the solid media, although both liquid and solid media had been used.

No. 3. After 14 weeks of practically no change, the colonies began to show active growth. The two very small colonies then became healthy green. They were loosely put together and grew to approximately 0.8 cm. in length and were half as broad.

No. 4. The colonies showed a steady increase in size throughout the 16 weeks. After 14 weeks the leaves on the lower portion of some of the stems became brown. The two large colonies were 1.3 cm. and 1.5 cm. in diameter. The leafy stems bore scattered rhizome-like branches among the leaves, which were of the usual form or were extremely irregular on the margin. There were many archegonia along the upper part of the leafy stems, some of them with wing-like outgrowths on the long neck (FIG. 7,W). Similar malformed archegonia were also formed on the plants of the earlier study (Fulford & Diller, 1956, fig. 26, 27).

No. 5. After nine weeks of healthy growth, the tips of some of the branches became yellow-brown and broke off within the next two weeks. At the end of 16 weeks there were five loose clusters of leafy stems and rhizomes from 1 to 2 cm. long. Thick clusters of small rhizome-like branches developed along the leafy stems on the rhizomes. The leaves were small and closely overlapping.

No. 6. The plants showed little or no growth from the beginning. After 16 weeks there was one short rhizome-like branch, which was still yellowish-green, on the original, thin, brown stem with brown leaves.

No. 7. Signs of deterioration were visible only a week after inoculation. No new leafy branches were formed. The original stem was approximately 1 cm. in length with several very short rhizome-like branches (FIG. 8). Some of the old leaves were brown except for scattered masses of green cells along the margins

leaf, × 15. 2. A leafy stem from medium no. 1, L, leaf, R, rhizome-like branch, × 15. 3. A leaf from this plant, × 38. 4. Portion of the margin of this leaf, P, slime papilla, × 350. 5-6. Leaves with pouches from a plant grown in medium no. 2, C, pouch, L, leaf, R, young rhizome, × 50. 7. A malformed archegonium with wings along the neck, on a plant from medium no. 4, W, wing, × 85.

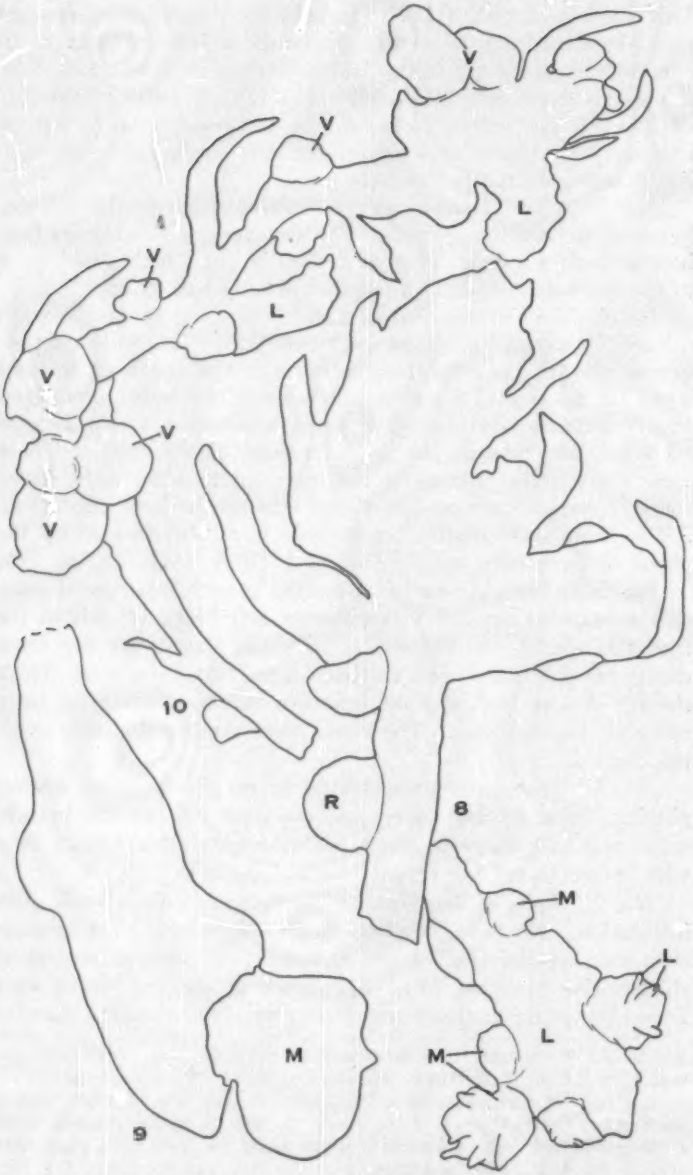

FIG. 8-10. *Haplomitrium hookeri*. 8. A stem from medium no. 7, show-

(FIG. 8, 9,M). Some of these cells masses resembled the rhizomes and had several minute leaves; others were just piles of cells and showed no indication of differentiation.

No. 8. After 16 weeks there was very little growth, and no new stems or branches were formed during that period. It is doubtful whether new leaves had been formed. The only apparent growth was the formation of many irregular piles of cells between the distant leaves along the stem (FIG. 10,V). Such piles of cells appear to have no relationship to the cylindrical rhizomes or rhizome-like branches since they were irregular in outline and gave no indication of the formation of the scale-like leaves often found on young rhizomes.

No. 9. The colonies in both flasks showed excellent growth in compact, bright green, spherical masses about 1.5 cm. in diameter. After about 14 weeks the lower leaves of the stems began to lose their color, and by the end of 16 weeks the colonies were colorless (hyaline) except for a few leaves at the stem tips. The leafy stems were robust, and the large leaves were closely set (FIG. 11). The only means of vegetative multiplication of these plants was the formation of new rhizomes from the stem among the leaves and from the branched rhizome at the base of the stem. These soon became leafy stems. No archegonia were produced.

No. 10. The colonies in both flasks showed excellent growth in the form of compact, bright green, spherical masses. Four of them were 1.5-2 cm. across, and three were smaller. The stems were robust, with large crowded leaves (FIG. 12, 13). Frequent short rhizome-like branches developed on the stem between the leaves (FIG. 12, R) and on the rhizome base. As in medium no. 9, the colonies began to lose their green color after about 12 weeks, and after 14 weeks they were hyaline.

No. 11. The colonies and plants in this medium were much like those in nos. 9 and 10 above. There were two large colonies, 1.5 cm. and 2 cm. in diameter, formed of robust stems with large, well-formed, crowded leaves. After 14 weeks the green color began to disappear, and after 16 weeks only a few small leaves at the tip of a stem were still green. Young rhizomes from the stem were numerous among the leaves and soon formed leafy stems, as did the branches of the old rhizomes. There were no

ing masses of cells along the leaf margins, L, leaf, R, rhizome, M, masses of cells on the leaf, × 38. 9. A leaf from this plant, showing one large marginal mass of cells, M, near the tip, × 85. 10. A leafy stem from medium no. 8, showing many irregular piles of cells along the stem, L, leaf, V, pile of cells, × 50.

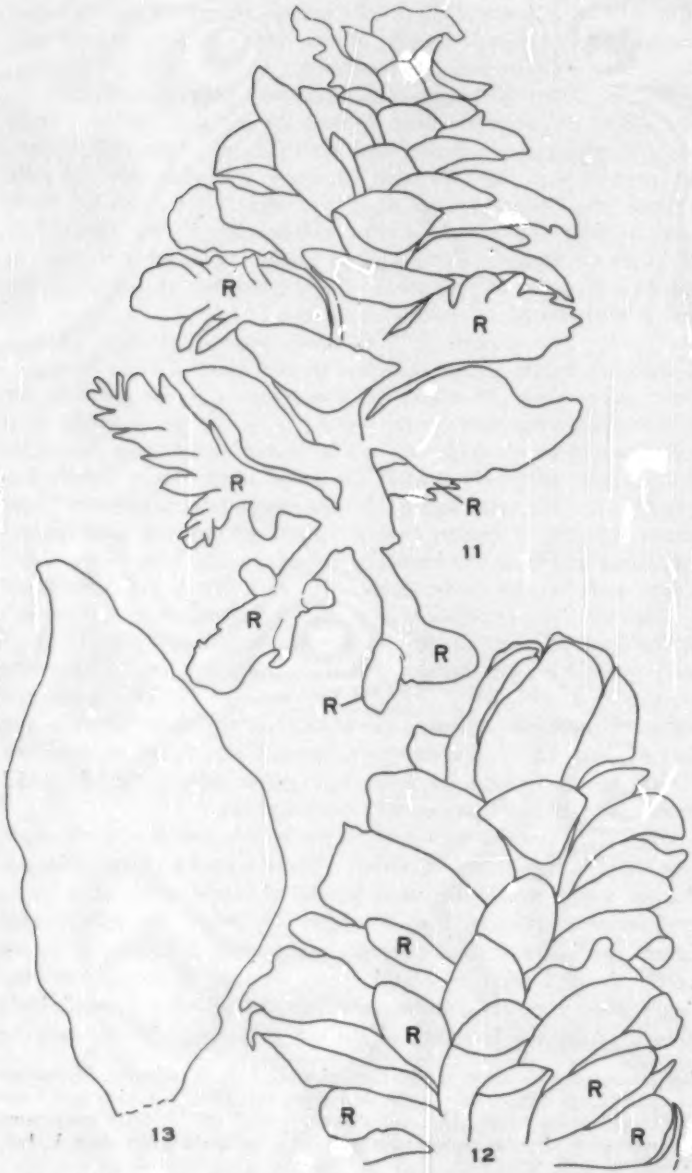

FIG. 11-13. *Haplomitrium hookeri*. 11. A robust stem from medium no.

other forms of vegetative reproduction evident, and no archegonia were formed. The general results may be summarized in TABLE 1.

TABLE 1

MEDIUM	ORGANIC NITROGEN SOURCES	DIMENSIONS OF COLONIES (CM.)	DRY WEIGHT OF COLONIES PER FLASK (MG.)	ARCHEGONIA	COLOR OF COLONIES	GENERAL RESPONSE OF PLANTS
1	none	0.8-1.0	38	–	green	good
2	tryptone	1.5-2.3	268	–	green	excellent
3	casein	0.8 × 0.4 (stems)	9	–	green	14 weeks-poor 2 weeks-good
4	arginine histidine lysine	1.3-1.5	5	+ (abnormal)	green; brown after 14 weeks	poor
5	tyrosine tryptophane phenylalanine	1.0-2.0 (stems)	59	–	green; some branches brownish-green	poor
6	cystine methionine	0.4-0.8 (stems)	<1	–	light brown	very poor
7	threonine serine	0.5-1.0 (stems)	7	–	yellowish-green	poor
8	leucine isoleucine valine	0.3-0.7 (stems)	14	–	brownish	very poor
9	glutamic acid asparatic acid	1.5	85	–	bright green; decolorized (hyaline) after 14 weeks	excellent
10	glycine alanine	1.5-2.0	266	–	bright green; hyaline after 13 weeks	excellent
11	proline hydroxyproline	1.5-2.0	134	–	bright green; hyaline after 14 weeks	excellent

DISCUSSION

The literature provides little specific information concerning organic nitrogen utilization by Hepaticae or the composition of their plant proteins and soluble nitrogen compounds; also, no

9, R, rhizomes or rhizome-like branches, × 15. 12. Portion of a robust stem from medium no. 10, with rhizome-like branches, R, among the leaves, × 15. 13. A leaf from this plant, × 85.

knowledge is available on the enzymes involved in nitrogen metabolism which might be present in these plants. In experiments with *Sphaerocarpos texanus*, when tryptone was available in addition to inorganic nitrogen, there was evidence that the organic nitrogen was utilized and retained in a larger proportion than the inorganic (Schuler *et al.*, 1955). Therefore, the present experiment was designed to investigate the effects of various amino acids on the rate of growth and development of plants of *Haplomitrium*.

On the basis of an analysis of the form and structure of the plants grown in the various media, evaluations were made of the amino acids important for typical growth and development. These should be significant in providing further data on suitable synthetic media and in supplying information concerning some of the forms of organic nitrogen which may be utilized by *Haplomitrium*.

Although abundant growth was obtained in the tryptone medium, the individual plants were not so robust as those in some of the other media, and there was much more vegetative reproduction by rhizome-like branches from the leafy stems and from leaf pouches. In contrast, the plants in the medium with casein hydrolysate did not do as well, since there was practically no change in the size of the colonies until after 14 weeks. This condition might be attributed to a lack of "growth factors" in the casein hydrolysate.

Of the various substances used in this experiment, the excellent growth of the plants and colonies in media nos. 9 (glutamic acid and aspartic acid), 10 (glycine and alanine), and 11 (proline and hydroxyproline) indicates that any one of these three combinations of amino acids provides desirable sources of organic nitrogen to incorporate in the medium for *Haplomitrium*.

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SOME TECHNIQUES IN THE CULTURE OF MOSSES

MAX WARD[1]

An increased interest in the mosses as experimental plants has focused attention on their culture *in vitro*. Aspects of their physiology have received attention in recent years, and the older problems of vegetative multiplication ("regeneration") have been taken up by other workers. Taxonomic studies are now contemplated by investigators using *in vitro* culture practices. The present studies on mosses, chiefly centered around embryological and developmental aspects, have made use of such culture methods, some features of which are offered here.

COLLECTION, STERILIZATION, AND STORAGE OF SPORES: Ripe, unopened capsules, with both operculum and calyptra intact, are collected to provide spores for initial plantings. In such condition, contamination is not at all likely, and sterilization can be conveniently effected without injury to the spores within. The calyptra (with such modifications as found in *Polytrichum*) is removed just before sterilization. About 5 mm. of the seta are left attached to each capsule for ease in handling.

A solution of freshly mixed and filtered Pittchlor[2] (5 g. per 100 cc. of distilled water) is found effective for sterilization. The capsules are shaken lightly in the chlorinated solution for a suitable time (about five minutes is often adequate), then washed in sterile water and dried between sterile, dry paper towels. The capsules thus prepared may be stored in a tightly capped specimen bottle to maintain them in sterile condition for several months. Storage is done at room temperature, or in the refrigerator, if desired. Spores of common species may remain viable for months without refrigeration. (Spores of *Polytrichum*, for example, have continued viable for nearly two years while stored at room temperature.) At planting time, a single capsule may be removed and held by the seta while the spores are removed on a sterile glass slide with a dissecting needle or spear point.

[1] Glenville State College, Glenville, W. Va. This research was supported by grants from the National Science Foundation (G-6081 and G-8650). The work was part of a research project directed by Prof. R. H. Wetmore as principal investigator under the grants at the Biological Laboratories, Harvard University.

[2] Granular calcium hypochlorite, a product of the Columbia-Southern Chemical Corp., Pittsburgh 22, Pa.

THE MEDIUM: Knudson's medium, as previously used for growing fern prothallia (Ward, 1954), with micro-elements (Nitsch, 1951) as used extensively in these laboratories, has been found satisfactory for several species of mosses. Sucrose in concentrations from 0.25% to 2% enhances growth of the protonemata and leafy plants. Higher concentrations are found to be of no advantage. Spores will germinate slowly and plants may grow on still higher concentrations, although erratic and very slow growth may be expected. (Mosses have been grown on sucrose concentrations as high as 20% in special experiments in the current studies. In additional trials, also unrelated to general culture of mosses, concentrations of naphthalene acetic acid up to 4 p.p.m. have been used. Induction of lightly colored protonemata is greatly stimulated, but normal budding has not taken place. This growth substance has not been used in general culture.)

In general, the pH of the medium is not critical. The pH of the soil where moss grows well in the field can be determined by testing with appropriate paper or other chemical indicators. Close approximations may be obtained by measuring with an electronic meter the distilled water that has been poured over a shovelful of growing moss plants and attendant soil as collected in the field. Rather consistent readings may thus be had from water allowed to remain in contact with the plants and soil for about 30 minutes. (*Polytrichum* is found to grow well at a pH of 5.2.)

A 1% agar concentration is generally satisfactory for the medium. It is dispensed in deep glass containers (Pyrex storage dishes, no. 3250), which are quite advantageous for the upright habit of leafy plants. Flasks, culture tubes, and other containers may be used for special needs. The agar, in amounts up to 150 cc. per dish, is slanted sharply while cooling to facilitate drainage of condensed water. Failure to do this allows collection of water at random surface areas with adverse effects on protonemata and young plants.

Sterile spores are spread lightly with a sterilized brush over the surface of the agar slants. A very little practice can aid in judging the quantity to use. Contamination of cultures can be kept at a minimum if the sterilizing and planting operations are done in a sterile transfer room or chamber.

The planted culture dish is covered with polyethylene film, which is in turn held tightly in place with a rubber band below the glass cover (*fig.* 1A). Kept thus covered, the moisture in the original agar may be retained adequately for two years or

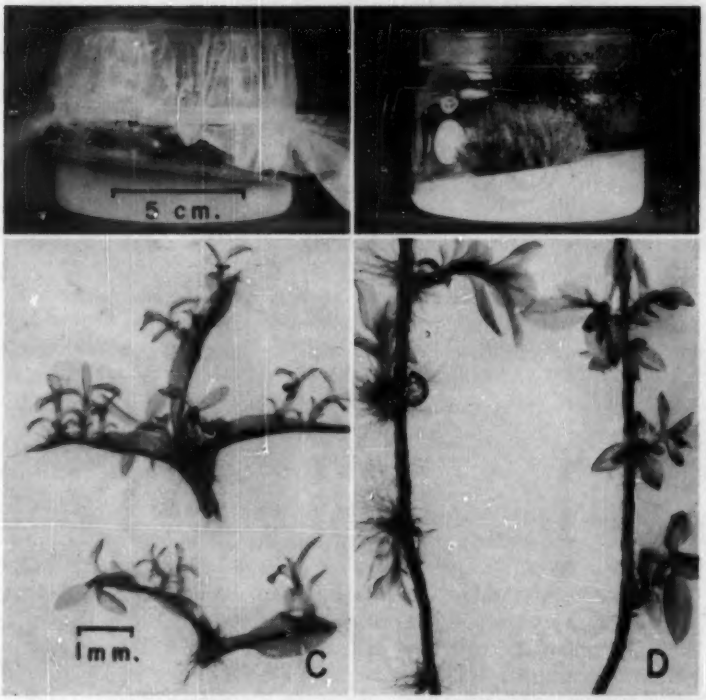

FIG. 1. Methods used in growing leafy gametophytes of *Polytrichum commune* from spores and from leaves and stem segments through vegetative propagation. *A*. Culture dish with protonemata and very short leafy plants after six months on original medium. Polyethylene cover film maintains moisture. *B*. Leafy plants the same age as those in *A* showing results of thinning and transfer to new medium (photographed with film cover removed). *C*. New shoots produced vegetatively on leaves attached to very short stem segments. (Shoots at this stage bear rhizoids, are easily detached, and can exist independently.) *D*. New shoots and abundant protonematal (and rhizoidal) outgrowths produced within 17 days on denuded stem sections.

longer. (Film thicknesses of 0.5 mil. to 1.5 mil. have been used with satisfactory results. Pertinent physical characteristics of the film employed, particularly as to conduction of water vapor, oxygen, and carbon dioxide, may be had from the manufacturer. Polyethylene films have been found significantly valuable in maintaining a constancy of conditions within the culture vessels. Passage of essential gases through the film seems to be adequate for the cultures.)

Neither temperature nor lighting is found particularly critical in growing common mosses. Many of the cultures are maintained at a constant temperature of 74° C. and under about 50-80 foot-candles of mixed incandescent and fluorescent light. Very similar growth is obtained with indirect window light and room temperature, particularly through the months from autumn to spring. Germination of many spores may be expected under these conditions within three to five days, and budding occurs in four to six weeks after planting, particularly if sucrose is used in the medium.

A significant acceleration in growth of leafy plants may be gained through transfer and regular thinning (*fig.* 1B). An original spore planting may be used to supply stock for many dishes. The very young, delicate plants are easily removed in small clumps from the surface of the medium with a spatula, carrying the plants undisturbed in a thin layer of agar. Plants well dispersed over the new medium maintain optimum growth.

MAINTENANCE AND RENEWAL OF CULTURE STOCK: Once a stock has been secured from spore plantings, it is usually advantageous with a number of mosses to extend or maintain them by vegetative propagation. Small clumps of protonemata placed on new medium will proliferate and give rise to buds faster than will new protonemata from spores. Either leaves or intact plants placed on culture media may produce multitudes of new plants in short order under the high moisture conditions noted for the original plantings. Individual leaves may give rise to several new plants within a few days; the stems of intact plants (of *Polytrichum*, for example) may produce independent leafy shoots an inch high within a month. Leaves still attached to short stem segments and even denuded stems may readily produce propagative growths within a few days (*fig.* 1C and D). In such vegetative multiplication—including use of protonemata—a sort of maturity seems inherent in the propagative parts used that permits a sharp abridgement of the time required to produce mature plants from spores.

Experimental use of amino acids, other organic supplements, and specific growth substances in moss culture has been reported by Burkholder (1959). He noted preliminary evidence for existence of "profound effects" of organic metabolites. Patterson (1957) has found accelerated growth in some mosses following use of indole-acetic acid. Gorton and Eakin (1957) have reported amino acid analysis for certain species. Von Maltzahn and

MacQuarrie (1958) described effects of gibberellic acid on protonematal growth. Marked stimulation in the initiation and growth of buds and young leafy plants has resulted from x-ray treatment in other phases of the present investigations in mosses. No use of irradiation has been made as a culture practice.

Although specific experiments with moss plants often may require complicated media and elaborate techniques, the quantity production of plants for experimental use may result from fairly simple techniques, media, facilities, and equipment.

The technical assistance of Miss Lydia Thomas is acknowledged. Determinations of several species of mosses were made by Dr. Frank J. Hilferty.

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STUDIES IN LEJEUNEACEAE. I. THE TYPIFICATION OF LEJEUNEA

C. E. B. BONNER and H. A. MILLER[1]

The genus *Lejeunea* was established in 1820 by Mlle. Marie-Anne Libert of Malmedy in a paper entitled "Sur un genre nouveau d'hépatiques, *Lejeunia*." This paper was published in Bory de St.-Vincent, Drapier, and Van Mons' *Annales Générales des Sciences Physiques, Bruxelles,* vol. 6. Two species are described in this paper. Each has a short Latin diagnosis and a figure on Plate XCVII. The genus itself has no Latin diagnosis but a de-

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scription in French which is limited to that of the capsules. The absence of the Latin diagnosis is of no consequence as the genus was described before 1 Jan. 1935 (Art. 34, Intern. Code Bot. Nomencl., 1956). The genus can therefore be considered as validly published. The two species in question are *Lejeunia calcarea* and *Lejeunia serpillifolia,* published in that order. No type species is indicated.

The Species

I. *L. calcarea.* Latin diagnosis: Lejeunia foliis acuminatis, biseriata-imbricatis exstipulatis. Based on: (a) A sample presumably of the Malmedy area (not seen by the authors). (b) Plate XCVII, fig. 1. (c) Micheli, Nova Plant. Gen. Tab. VI, fig. 19. (d) Dillenius, Hist. Musc., Tab. LXXXII, fig. 30.

Description (translated): This hepatic is one of the smallest of the family. Its stems, hardly visible to the naked eye, are creeping, filiform, irregularly branched, at times almost pinnate. Its leaves are imbricate and arranged in two rows. They are oval, acuminate, rounded at the base, transparent, appear to be covered with papillae, auriculate or bilobed, the upper lobe fairly large, the lower one smaller and saccate at the base. The calyx is pyriform, angular down to its insertion, axillary or lateral; the pedicule which emerges from it is slender and very short, shorter even than the calyx.

This plant has a yellowish tinge; it grows among mosses on calcareous rocks, in shaded places. It fruits in the autumn.

II. *L. serpillifolia.* Latin diagnosis: Lejeunia foliis obtusis distichis stipulatis. Based on: (a): A sample presumably of the Malmedy area. (b) Plate XCVII, fig. 2. (c) *Jungermannia serpyllifolia* Dickson, Fasc. IV, p. 19, *excl. syn.* Mich. (d) Hooker, Brit. Jung. fasc. XI, t. 42, *excl. syn.* Mich. (e) De Candolle, Flor. Fr. VI, no. 1145, *excl. syn.* Mich.

Description (translated): The stem of this second species is creeping, filiform, irregularly branched, occasionally pinnate; its leaves are imbricate, transparent, aranged in two rows, generally oblong, rounded, auriculate or bilobed; the upper one is large, obtuse, bulging at the base, and the lower lobe is much smaller, clasping the stem.

The underleaves are situated at the base of these leaves, and all of them on the same side. They are rounded and deeply bifid; the two lobes are pointed. The calyces are axillary or lateral,

rarely terminal; they are proportionally more elongate than those of the previous species, angular, particularly near the top. The pedicules of the capsules are thick and when fully developed equal the calyces in length.

This second species of *Lejeunia* is much bigger than the preceding one in all its parts. Nevertheless, like the former, it is hardly visible to the naked eye. It bears fruit in the autumn. It is found in damp and shaded places, on old tree stumps and rocks amongst the mosses growing on them.

Two species have thus been described. One has been given a new name and the other is in effect a transfer of *Jungermannia serpyllifolia* Dicks. *pro parte*. It would appear that of the two species, the older one, *L. serpyllifolia,* was chosen as the type of the type of the genus (Nees, 1833, p. 97). Although this conforms to the principles of priority of the present code of nomenclature, it is unfortunate for the following reasons that Mlle. Libert should have chosen the epithet *"serpillifolia":*

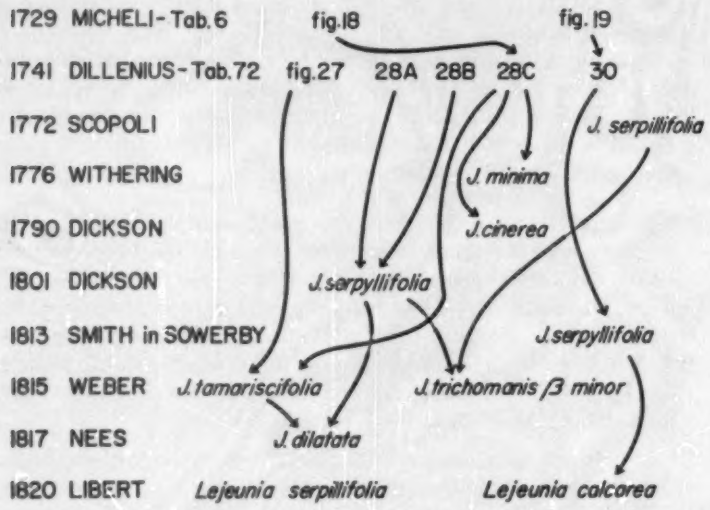
(a) It is a later homonym of *Jungermannia serpillifolia* Scop., 1772, which is *Calypogeia trichomanis.*

(b) Dickson's *Jungermannia cinerea* was published ten years earlier (1790) and was based on the same type (Micheli, 1729, Tab. 6, fig. 18 ≡ Dillenius, 1741, Tab. 72, fig. 28c) as his *J. serpyllifolia.* The latter is therefore a superfluous name.

(c) Hooker (1816) in his version of *J. serpyllifolia* followed Smith (1813) in appending the name to a different type (Micheli, 1729, Tab. 6, fig. 19 ≡ Dillenius, 1741, Tab. 72, fig. 30.) explaining that Dickson must have made an error and that he meant Tab. 72, fig. 30 when he published Tab. 72, fig. 28. Further, Hooker referred Dickson's *J. cinerea* to *J. dilatata* (= *Frullania dilatata*). The reader may be reminded at this point that Mlle. Libert cited Micheli, Tab. 6, fig. 19, Dillenius, Tab. 72, fig. 30 as a synonym of her *Lejeunia calcarea!* We have attempted to show these changes in Table 1.

It may be argued that Dickson did not make an error when he cited Dillenius, Tab. 72, fig. 28, for when publishing *J. serpyllifolia* he did not cite Micheli. Furthermore, Dillenius Tab. 72, fig. 28 is composed of three illustrations A, B, and C. Only 28C is a copy of Micheli, Tab. 6, fig. 18, which can thus be referred to Dickson's *J. cinerea,* an epithet which is antedated by *J. minima* With. (1776).

TABLE 1. A synopsis of the complex preceding Libert's description of *"Lejeunia."*



Assuming therefore that *J. serpyllifolia Dicks.* is based on Dillenius, Tab. 72, fig. 28A or B, or both, according to S. O. Lindberg (1873, 1877) it must be referred to *Radula complanata.*

The epithet "serpyllifolia" or "serpillifolia" can therefore be considered as a *nomen confusum,* even when taking into consideration the possibilities offered by the note appended to art. 72 of the 1956 edition of the code of nomenclature where it could be possible to make use of an epithet which was previously employed in an illegitimate combination, regarding the new combination not as a transfer but as a new species.

To avoid any further confusion in connection with Mlle. Libert's type species of the genus *Lejeunea,* it is therefore proposed to rename it **Lejeunea libertiae** nom. nov.

An examination of the material from the Libert collection kept at the Jardin botanique de l'Etat, Brussels has revealed that of the seven specimens present on the sheet, only one is fertile. It follows therefore that, as a description of the female inflorescence is included in the diagnosis, the fertile specimen must be regarded as the type of the species. The label indicates neither locality, nor date, nor collector but that it originated from Dr. Lejeune's collection.

DESCRIPTION OF THE TYPE SPECIMEN: Autoicous: *Plants* yellow (probably pale green in nature), epiphytic, in admixture with other bryophytes; stems creeping, regularly pinnate, occasionally with a branch subtending each leaf, sterile lateral branches microphyllous in this situation: *Leaves* imbricate, the lobe arching beyond the axis, ovate, rounded to broadly acute at the apex, margins entire to slightly crenulate through the rounded outer walls of the individual cells; lobule often poorly developed (especially on microphyllous branches) but when normal, ovate, often inflated, obliquely truncate at the apiculate apex, keel arched, free margin entire, involute at apex: *Underleaves* orbicular, distant to about ½ with acute lobes, sinus acute to somewhat lunulate, entire, insertion onto the stem broad, 3-4 cells wide, cells thin-walled, a central small-celled patch at the base corresponding to the rhizogenous tissue: *Leaf cells* thin-walled with small trigones and intermediate thickenings, outer wall of marginal cells very thin and slightly bulging: *Female inflorescence* terminal, usually on a short lateral branch, innovating on one side or not at all, the innovation usually sterile but occasionally floriferous; bracts unequally bilfid, the lobe oblong, tapered toward the apex, entire; lobule lanceolate, acute; bracteole broadly ovate, bifid about ⅓ with acute lobes and sinus, entire; perianth pyriform, narrowed at the base, broadly truncate at the apex and with a small beak, the 5 rounded keels bearing sharp edges which extend about ⅓ the length of the perianth, cells regularly hexagonal without trigones: *Male inflorescence* borne on a short lateral branch, bracts 2-3 pairs, imbricate and strongly inflated: *Antheridia* not seen: *Sporophyte* with a globose, 4-valved, white capsule borne on an elongate, thin-walled seta, valves separated about ⅔ of the length, outer capsule wall composed of large thin-walled cells and inner wall with numerous irregularly thickened cells; elaters elongate, attached to the terminal part of the valve, with a single spiral thickening; spores not seen. (*Fig.* a-i.)

DIMENSIONS: *Stems:* up to 125 μ in diameter. *Leaves:* lobes up to 800 μ × 550μ, usually a little smaller but in approximately the same proportions, lobule up to 250 μ × 180 μ, usually smaller and in reduction of various proportions; underleaves 230 – 400 μ × 250 – 400 μ; cells at edge of lobe 15 – 21 μ in diameter, median cells 30 – 36 μ, slightly elongate. *Perianth:* 720 μ long × 480 μ diameter below keels. Cells of the perianth 21 – 30 μ; length of capsule 330 μ, width of valve 190 μ, elater diameter 6 μ, length unmeasurable in material.

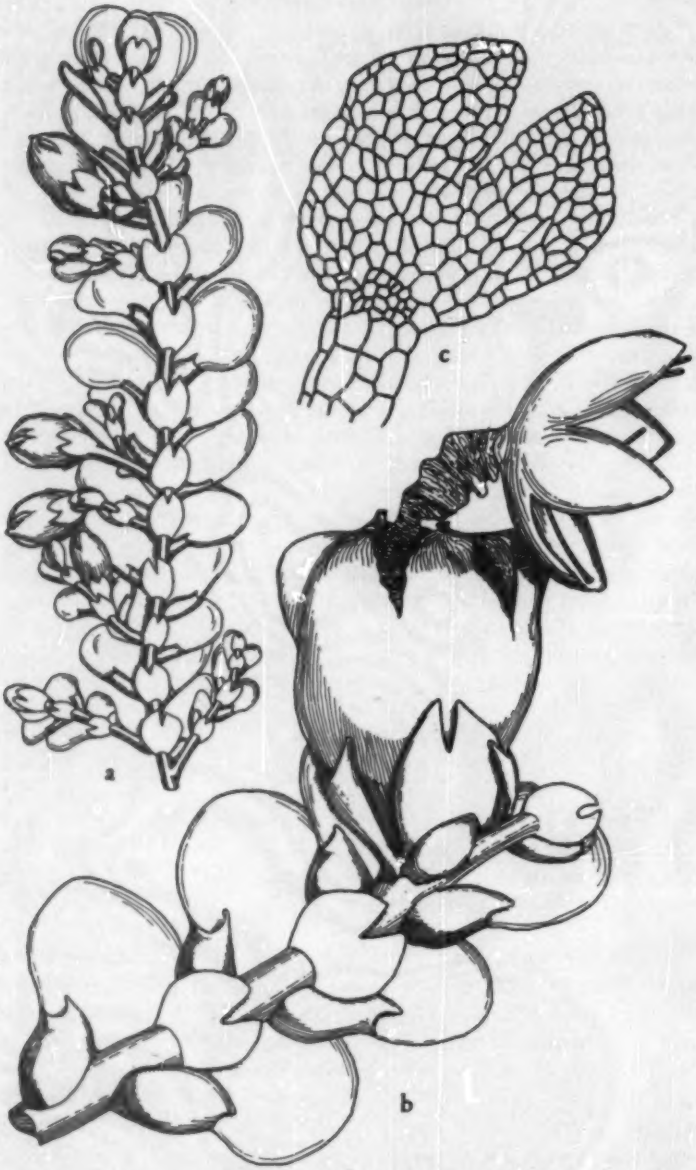


FIG. *a-c*. *Lejeunea libertiae*. *a*. Habit, × 20. *b*. Perianth with mature sporophyte, × 74. *c*. Underleaf, × 177. (Draw from the type.)

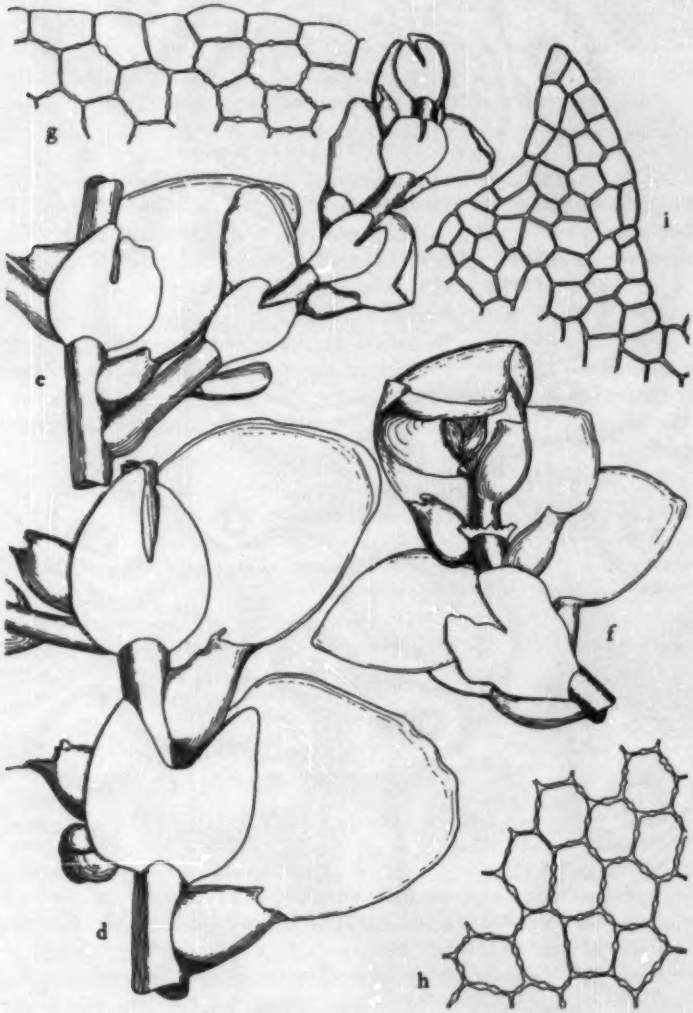


FIG. *d-i. Lejeunea libertiae. d.* Aspect of mature thallus with a male branch, × 66. *e.* Aspect of thallus bearing microphyllous branches at the base of each leaf, × 66. *f.* Terminal portion of a main stem showing acute leaf tips, × 66. *g.* Cells of leaf margin, × 288. *h.* Median cells of leaf, × 288. *i.* Detail of underleaf segment, × 288.

Inasmuch as the family Lejeuneaceae rests upon correct typification of *Lejeunea*, we have dealt first only with the problem of the generitype. We have excluded all synonyms of the taxon pending the review of types of other taxa as they become available.

On Spelling

The original spelling *"Lejeunia"* was followed by most bryologists for over 60 years. Hampe adopted *"Lejeunea"* in 1837 but subsequently (1851, 1852) reverted to the original form. The first major work using *"Lejeunea"* was Spruce's "Hepaticae Amazonicae" (1884, 1885) where the spelling was used in combination with Latin prefixes to indicate segregate subgenera. Spruce's spelling was followed at once almost universally, and Schiffner's (1895) acceptance of the spelling for *Die natürlichen Pflanzenfamilien* seemed to assure continuation of *"Lejeunea."* We are following current usage until the situation can be further clarified.

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"FRUITING" SPECIMENS OF SPHAGNUM PORTORICENSE

H. L. BLOMQUIST[1,2]

On May 8, 1960, when I was motoring with Mrs. Blomquist through southeastern North Carolina, we stopped to eat our picnic lunch by a beautiful lake in the western area of Bladen County, located on state highway 131, about half-way between the villages of Tarheel and Guyton. I had never traveled this portion of the highway before and did not know of this lake which we learned from some local residents is called Page's Lake After lunch, I walked around a small embayment nearby to see what might be growing on the marshy ground at its margin. Among the rather sparse seed plants commonly growing in such habitats, I noticed a few low tufts of *Sphagnum*, one of which appeared to be *S. portoricense*. Without examining this closely, I collected a small amount of it and another smaller species which was fruiting.

After returning home, I examined these *Sphagna* at the first opportunity and found that the one which resembled *S. portoricense* was indeed that species, and to my surprise discovered that it bore sporophytes which had not been raised above the perichaetial leaves. The smaller fruiting species was *S. subsecundum*. With the hope of finding more material of the former with more mature sporophytes, we made a special journey to this locality on

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[2] A contribution from a study of *Sphagnum* of North America supported by the NSF Grant G-4564.

June 12 and were well rewarded in finding a considerable amount, although fruiting specimens were not especially abundant.

Sphagnum portoricense Hampe (Linnaea 25: 359. 1852) was collected for the first time by Carl Schwanecke in Puerto Rico some time during the years 1847-1850. The description which Hampe furnished for this species was very brief and consisted mainly of comparing it with *S. palustre L.* The differences he mentioned were that the former had more closely imbricated leaves and the chlorophyllose cells were broader than in the latter. This description was wholly inadequate as it did not include the most distinctive characteristics of the species, such as the broad, hyaline, finely meshed margin of the stem leaves, the equilateral form of the transection of the chlorophyll-cells of the branch leaves, the fringe-fibrils on the inside of the walls of the hyaline cells where in contact with the chlorophyll-cells, and the funnel-shaped basal walls of the cortical cells of the branches. Regarding reproduction, he said that neither perichaetial leaves ("calyx") nor sporophytes ("fructus") were present.

Because of this inadequate description it is not surprising that this species was renamed twice, first by Austin (1863) as *S. Sullivantianum,* based upon material from New Jersey and, second, by Schimper ex Bescherelle (1876) as *S. Herminieri* after its collection in Guadeloupe.

During the span of over a hundred years since the type collection was made in Puerto Rico, the distribution of *S. portoricense* has been extended south to South America, west to Mexico, and north to the eastern United States from Florida and Louisiana to New Jersey. It is not infrequent in the southeastern states as far north as North Carolina but farther north, so far as I know, has not been collected except in New Jersey. All collections which have established this distribution have, so far as known, been non-fruiting. It should be mentioned, however, that Andrews (1913) reported that in the Sullivant Herbarium at Harvard University is a specimen contributed by Austin, which has antheridial branches. This would at least indicate that the species is dioicous as are all other species belonging to the subgenus INOPHLOEA in which fruiting specimens have been seen.

After making a study of the "fruits" of *S. portoricense,* my conclusion is that they are in general similar to those of the other entities which compose the INOPHLOEA. As in all species of *Sphagnum,* the archegonial branches are usually borne on the upper side of the base of the fascicles of vegetative branches (*fig.* 4ab-6ab), as was shown by Schimper (1857) in his classical mono-

graph on the morphology of the genus. The number of archegonia, he stated, ranged from one to five per branch. In the material of *S. portoricense* the number seems to be constantly three. As is well known, only one from each branch gives rise to a sporophyte, but it may happen that some branches do not bear a sporophyte (*fig.* 5). In that event they remain at the base of

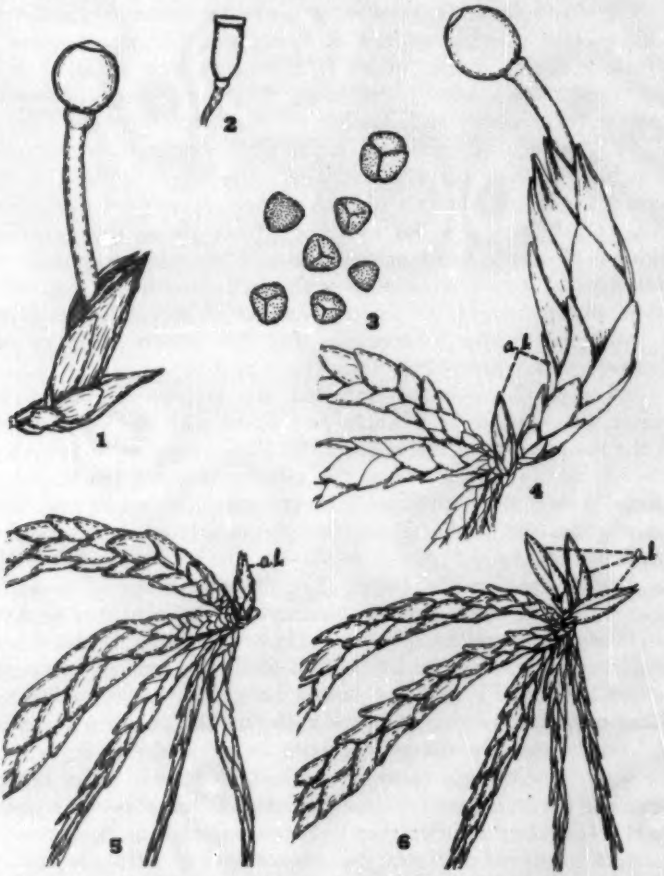

FIG. 1-6. *Sphagnum portoricense*. 1. Archegonial branch from base of capitulum with sporophyte, × 4.5. 2. Discharged capsule, × 4.5. 3. Spores, × 250. 4ab. Archegonial branches below the capitulum, one with sporophyte and one without, × 4.5. 5ab. A solitary archegonial branch at base of fascicle of vegetative branches, × 4.5. 6ab. Fascicle of 3 archegonial branches, × 4.5.

the fascicles for a considerable distance below the capitulum. In some specimens of the material I studied, none of the archegonial branches bore sporophytes, but by their presence down the stem one can distinguish the plant as female. However, this does not always mean that a plant *without archegonial branches* is *not* female, for, because of season, or for some other reason, a female plant may not bear archegonial branches when collected.

The above facts, as observed in *S. portoricense*, are, as far as I know, true of other entities of *Sphagnum*. However, there is a feature of this species which I have never seen or heard of in any other species, namely that more than one archegonial branch may be borne above each fascicle of vegetative branches (*fig.* 4, 6). I have seen as many as five. In other words, the archegonial branches may also occur in fascicles. But when fertilization has occurred, only one branch of each fascicle develops a sporophyte (*fig.* 4). Although, so far as I know from my own observations and that of others, this species is the only one with more than one archegonial branch associated with each fascicle of vegetative branches, because of the limited number of species investigated, it would be unwise to conclude that this feature is found exclusively in *S. portoricense*.

When fertilization has occurred, the archegonial branch resumes development as a whole *pari passu* with the development of the pseudoseta and the sporophyte. The extent of this development evidently depends upon the relative distance the branch is located below the capitulum. In general it is longer and with more leaves the farther it is from the capitulum at the time of development (*fig.* 1,4).

The true perichaetial leaves (*i.e.*, the uppermost) of *S. portoricense* are in general similar in size, form, and structure to those of other members of INOPHLOEA. They are mostly elongate-ovate, deeply concave, more or less ruffled at the tip, and, occasionally, ruffled horizontally near the base. In structure, the undifferentiated region, consisting of large, uniform cells, is ovate in outline and quite extensive, occupying about three-fourths of the area of the leaf. The margin consists of a distinct hyaline, more or less fimbriate border as in the closely related *S. imbricatum* Hornsch.

The pseudoseta varies greatly in thickness and in length and is more often curved than straight. The capsule is dark brown, varying in shape from almost spherical to distinctly broader than long (*fig.* 1,4), averaging 2.6 mm. by 3 mm. in diameter. The spores range in size from about 18.75 μ to 26 μ in diameter and are minutely papillose.

Since it was expected that among the non-fruiting plants some plants would be male, a search was made for antheridial branches, but, so far, without success.

In conclusion I should add that this study of the fruiting plants of *S. portoricense* has not contributed anything new to the consideration of its relationship to other species of *Sphagnum* beyond confirming previous opinion that it belongs to the subgenus INOPHLOEA and is undoubtedly most closely related to *S. imbricatum*.

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NOTES ON NORTH AMERICAN SPHAGNUM. XII. SPHAGNUM CYCLOPHYLLUM

A. LEROY ANDREWS[1]

After having cast doubt on the claims to specific or varietal status of the various subsimplex forms of *Sphagnum subsecundum* from other parts of the world, as Åberg had also done, I may seem inconsistent in treating *S. cyclophyllum* as an independent species. As a matter of fact it has a long history as a taxonomic entity of one or another degree, and it is my purpose here to present its claims to recognition rather than to assert absolute validity for them. It is obviously closely related to *S. subsecundum*, and my conception of it would be that of a derivative of that species by reduction rather than the subgeneric or even generic status proposed by Lindberg. Specimens (with sporophytes) collected near New Orleans were first distributed by Drummond in his second set of *Musci Americani* (No. 17, 1841) under the name *Sphagnum obtusifolium* β *turgidum* Hook.[2] The current specific name *S. cyclophyllum* Sull. & Lesq. was published by Sullivant in Gray's *Manual*, second edition (p. 611, 1856), and specimens

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[2] *S. obtusifolium* Ehrh. is understood to be *S. palustre* L.

were distributed in both editions of Sull. & Lesq. *Musci Bor. Amer.* as well as by Austin in *Musci Appal.*

The characters in which *S. cyclophyllum* resembles *S. subsecundum* are the one to two layers of cortical cells and the general features of the leaf including the small pores along the cell commissures, varying from numerous to much reduced in number, quite as in *S. subsecundum.* The differences in the usually sterile specimens are not great, certainly not from the occasional subsimplex forms of *S. subsecundum* found in various parts of the world. The short erect stems with no branches or sometimes single inconspicuous erect branches involve large stem leaves not different in areolation from branch leaves of *S. subsecundum* forms. But I have employed one difference which I do not find emphasized elsewhere, though it is included in Warnstorf's description and figure of his *S. microcarpum:* a slight difference in the cross-section of the chlorophyll cells of the leaves. In *S. subsecundum* these cells are normally exposed about equally on both sides of the leaf; if a difference exists the greater exposure is on the dorsal surface, as generally in the series CUSPIDATA, in which I have included *S. subsecundum.* In *S. cyclophyllum,* on the other hand, I find the greater exposure on the ventral surface. In subsimplex specimens of *S. subsecundum* from other regions I do not find this feature, nor is it represented in published drawings of such forms. The difference is admittedly not great, may not be found to be completely consistent, and considered alone, might well not be convincing. There are, however, in the rare cases when sporophytes are produced differences that seem of more fundamental importance, and the plants are not of sporadic occurrence, but relatively frequent in a definite geographical area, associated with other distinct species characteristic of the same area. So important did S. O. Lindberg consider the sporophyte differences that in his important Promotionsprogram treating the *Sphagna* of Europe and North America[3] he placed *S. cyclophyllum* together with *S. Pylaesii* Brid. in a subgenus HEMITHECA separate from EUSPHAGNUM and suggested that the subgenus might well be considered a distinct genus. The elder Lindberg was a remarkable bryologist, well in advance of his generation in many respects, particularly in his insight into moss relationships, and while he may have gone too far in his taxonomic isolation of the two *Sphagnum* species, his careful morphological observations are

[3] Europas och Nord Amerikas Hvitmossor. Helsingfors, 1882. I possess the copy presented by the author to Limpricht. Section HEMITHECA for *S. Pylaesii* had been published already in Braithwaite, Sphagnaceae. 1880.

still worthy of all respect. The perichaetial leaves of *S. cyclophyllum* hardly differ from the other leaves, having throughout the normal alternation of hyaline and chlorophyll cells, the hyaline cells with the normal fibrils and pores. *S. subsecundum*, on the other hand, like the other CUSPIDATA species, has the alternation of hyaline and chlorophyll cells confined to a very limited upper central portion, the hyaline cells even there being generally without fibrils and only with small membrane gaps on the inner surface. The spore capsule of *S. cyclophyllum* is, so far as observed, borne on a short pseudopodium so that it hardly projects beyond the perichaetial leaves, is decidedly small with operculum nearly as large as the rest of capsule, the latter without pseudostomata. The matter of pseudostomata is very important, and I intend to treat it more at length under *S. Pylaesii*. In the *Transactions of the British Bryological Society* (3: 228ff. 1957) there is by Jean A. Paton and Jean V. Pearce a valuable summary of the occurrence of stomata among the moss genera, including the variant type found on the *Sphagnum* capsule. I believe the term pseudostomata should be retained for the latter as they obviously do not function as stomata and their origin as such, though generally assumed, is at any rate not wholly clear. The pseudostomata are completely lacking in the capsule of *S. Pylaesii* and according to Lindberg's description of his subgenus HEMITHECA also in *S. cyclophyllum*, of which it is true he had only a single capsule from the Drummond collection to work with. Austin, that indefatigable searcher, found in New Jersey fruiting plants of *S. cyclophyllum* and also specimens with antheridia, showing that the species is definitely dioicous, as for that matter is also *S. subsecundum*. Austin's material was available to me from the Lesquereux Harbarium, whose *Sphagnum* specimens were borrowed for me by Mrs. Britton, and in 1912 I also examined Austin's collections as represented in the Sullivant Herbarium incorporated in the Farlow Herbarium at Harvard University. The fruiting specimens were well supplied with sporophytes, and I examined them very carefully without finding any pseudostomata. The capsules of *S. subsecundum* are quite normal with elongated erect pseudopodia and a full quota of pseudostomata.

Lindberg adds other features of the capsule either expressly or through implication by his description of the subgenus HEMITHECA, corresponding to those of *S. Pylaesii:* that it is small with relatively large operculum, being then hemispherical with wide mouth and not contracted when deoperculate and empty, that its walls are thin, the exothecial cells with thin walls and unthick-

ened corners. The normal *Sphagnum* capsule is spherical with small operculum, becomes somewhat subcylindrical with strong lateral contraction when deoperculate and empty, its walls are thick and solid with exothecial cells thickened in corners. A few other points adduced by Lindberg seem to me of more questionable value. That the sporophytes are borne on single short lateral branches is hardly remarkable as any branches of *S. cyclophyllum* are short and single; with the further elongation of the normal capitulum the branches of *S. subsecundum* and other species become lateral and their sporophyte–bearing branches are merely specialized members of the regular branch fascicles. His statement that the terminal cortical cells of the *S. cyclophyllum* stems are retort cells with a pore at the upper end I have not been able to verify satisfactorily in herbarium material. At the same time it is to be noted that the cortical stem cells of well–developed forms of *S. subsecundum* tend to show a pore at their upper end, not always easy to make out. Lindberg's point about the fibrils, or fibril bands of the hyaline leaf cells is also hardly diagnostic. He seems to conceive of them as representing something of a transition to those of *S. Pylaesii*, which are admittedly extreme. Appealing is his argument that the fact that *S. cyclophyllum* has been found fruiting at both extremes of its range (in Louisiana and New Jersey) shows that it is an independent species; that is, it cannot be regarded as a merely juvenile or defective form, but must be considered fully mature.

In 1913 I had reduced to synonomy with *S. cyclophyllum* both *S. microcarpum* Warnst. 1891 and *S. Alabamae* Warnst. 1907. This calls for some explanation and revision. *S. Alabamae*, collected by Harper, was without sporophytes and, apart from subsimplex or rather oligoclad condition, lacked definite characters of *S. cyclophyllum;* it should perhaps rather be included among the many synonyms of *S. subsecundum.* I find I have been guilty of misnaming some other similar specimens *S. cyclophyllum* instead of *subsecundum.* The case of *S. microcarpum* is different and so critical as to require lengthier discussion. The original description and illustration by Warnstorf,[4] based upon specimens from the Cardot Herbarium, collected in eastern Louisiana and Pass Christian, Mississippi, by Langlois, fit closely both as to gametophyte and sporophyte *S. cyclophyllum*, except that unfortunately Warnstorf did not state whether the capsule had pseudostomata or not. The same applies to Warnstorf's monograph of 1911, (p. 370), but he has there annexed further collections of

[4] Hedwigia 30: 170f. 1891.

cyclophyllum to his much later *microcarpum*, even including in garbled form the early collection of Drummond: "New Orleans (Sull. et Lesq. in Musc. Bor. Amer. n. 17)." It was of course Drummond's specimen, not those issued by Sullivant and Lesquereux that was from near New Orleans and numbered 17. Under *S. cyclophyllum* (p. 425) are cited both Drummond's and S.&L.'s exsiccati. In exchange for fruiting *S. Pylaesii* Cardot furnished me type material of *S. microcarpum* from Louisiana and Mississippi, which I carefully studied. The plants are not typical *S. cyclophyllum* as they show considerable branching (with erect branches) and smaller, not so rounded leaves. Their spore capsules also have pseudostomata, which both Lindberg and myself failed to find in typical *S. cyclophyllum*. Those on the capsule of *S. microcarpum*, it is true, are neither so numerous nor conspicuous as on normal *Sphagnum* capsules, and if their function has to do with the lateral contraction of the capsule in spore emission as seems probable, they are not functioning well in *S. microcarpum* as its capsule is not much if any contracted and is not erect on a lengthened pseudopodium, which are necessary prerequisites for the normal emission of *Sphagnum* spores, as will be discussed later. But if *S. microcarpum* is not fully typical *S. cyclophyllum*, it is also hardly normal *S. subsecundum*. Not only is its capsule different in form and function, as just described, but the perichaetial leaves have the normal leaf areolation throughout with alternating chlorophyll cells and fibrillose hyaline cells, corresponding to those of *S. cyclophyllum*, but entirely different from those of *S. subsecundum*. The presence of pseudostomata in the capsule of *S. microcarpum* explains my description in 1913 of the spore capsule of *S. cyclophyllum* as being "with or without pseudostomata." This is admittedly not very satisfactory, but until there is further collection and study of fruiting material of *S. microcarpum* and *S. cyclophyllum*, I would hesitate to claim two separate species independent of *S. subsecundum*. Whatever category one may choose for them, from their characters the two might seem to represent stages in a process of evolution or degradation analogous to if not actually leading to that of *S. Pylaesii* from the variable *S. subsecundum*. *S. Pylaesii* has a simplex variety *sedoides* quite analogous to *S. cyclophyllum*. As to its evolution, however, *S. Pylaesii* both in its irregular distribution and otherwise appears to be an old species rather than one recently evolved. As a matter of fact, difficult though some of them may be, there is no evidence that any *Sphagnum* species has been recently evolved.

As to the distribution of *S. cyclophyllum*, not much is to be added to Lindberg's statement that its limits are New Jersey and Louisiana; that is, it is one of the coastal species of eastern North America. It has been reported from the New Bedford area of Massachusetts,[5] which would not be inconsistent, but Dr. Hilferty informs me there is no specimen extant to confirm the report. At the other end of its distribution I have a specimen (sterile) from near Newton, Newton Co., Texas, boggy soil in longleaf pine belt, collected by Miss Eula Whitehouse in 1950. Warnstorf reports it from South America,[6] Minas Geraes, southern Brazil, that is, from the same region as the similar *S. caldense* C.M., which may be a synonym. I examined type material of the latter in the Farlow Herbarium and the type itself in Berlin, but rather hurriedly in the last moments of my stay and the very old sterile plants did not lend themselves well to section-cutting so that I hesitate to pass judgment on the species; it certainly looks like *S. cyclophyllum*. It may be added that the further coastal species *S. portoricense* and *S. erythrocalyx*, which I collected with *S. cyclophyllum* in 1911 and 1913 at Toms River, New Jersey, at approximately the northern point of their distribution, also reach South America, *S. erythrocalyx* having been originally described from Brazil and *S. portoricense* recently recognized by Bartram in material collected in Venezuela.

In summary, it would seem that *S. cyclophyllum* should not at present be discarded as a synonym or mere form or variety of *S. subsecundum*, but that in some respects *S. microcarpum* Warnst. is intermediate between the two. That the latter is an independent species is not clear; it is better left provisionally as a variant form of one or the other of the two species until further collections of fresh sporophytes of all these forms permit more exact study of their interrelationships. It cannot be emphasized too strongly that the sporophytes of *Sphagnum* species are not all exactly alike and that their study up to the present has been very inadequate.

[5] See Hilferty, Rhodora 62:150. 1960.
[6] Sphagnologia Universalis. 425. 1911.

PSEUDOSCLEROPODIUM PURUM IN THE PACIFIC NORTHWEST[1]

ELVA LAWTON[2]

During the summer of 1959 Miss Kathleen Young found large quantities of sterile *Pseudoscleropodium purum* in the lawn at 17540 – 32nd. Ave. N. E., Seattle, Washington. This moss, not previously reported from continental North America, was later found in a clump of Iris in a garden in the same general region, but has not been collected in any other lawns or gardens examined, and it is not known from uncultivated areas of the state. It was probably introduced from Europe several years ago when some garden plants were imported. The moss is now well established and may be classed as a weed which will probably spread in the lawns. Neither capsules nor sex organs have been found, and the description of the fruiting plants is taken from European material.

Pseudoscleropodium purum (Hedw.) Fleisch., Musci Fl. Buitenzorg 4: 1136. 1923. *Hypnum purum* Hedw., Sp. Musc. 253, pl. 66. 1801. *Hylocomium purum* (Hedw.) DeNot. Epil. 91-92. 1869. *Brachythecium purum* (Hedw.) Dix., Stud. Handb. Brit. Moss. 410. 1896. *Scleropodium purum* (Hedw.) Limpr., Die Laubm. 3: 147-149. 1896. Plants large, 2-6 inches long, yellow-green to whitish-green, branching more or less regularly; branches in one plane, julaceous, usually obtuse at apex; leaves deeply concave, broadly oval or ovate-oblong, not plicate except under pressure, with a small abrupt apiculus which is often reflexed and with a few decurrent cells; margins plane or involute above, reflexed near base, entire or serrulate near apex; midrib to about the middle of leaf, sometimes shorter and occasionally forked; stem leaves entire or nearly so, 1.8-2.8 × 1.2-1.8 mm.; branch leaves smaller and usually serrulate at apex; median leaf cells long, 5-7 × 50-80, rarely to 100 μ long, cells shorter and often with pitted walls near base, a small area of alar cells rectangular or quadrate, not inflated or conspicuously differentiated. Dioicous, male and female plants similar; perichaetial leaves without midrib, long-acuminate; seta smooth, 2.5-4.5 cm. long; capsule 2-2.5 mm. long, horizontal to

[1] This work was made possible by a grant from the Biological and Medical Research Fund of the State of Washington.

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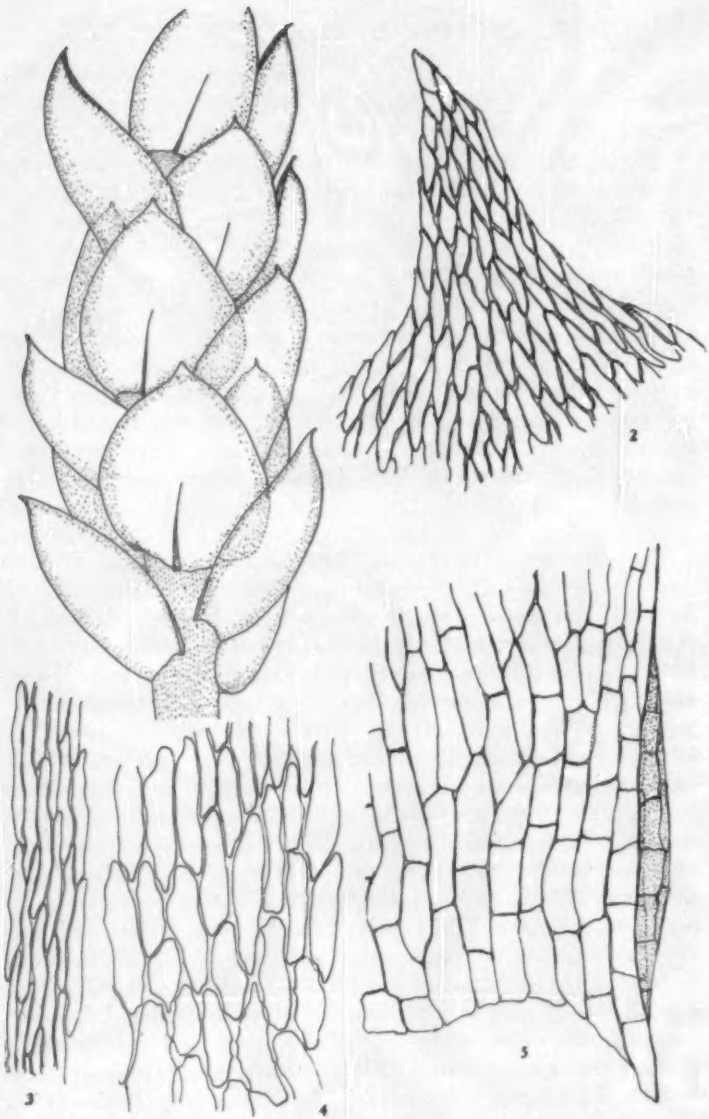

FIG. 1-5. *Pseudoscleropodium purum*. 1. Part of stem with leaves, × 15. 2. Cells of apical region of leaf, × 365. 3. Median leaf cells, × 365. 4.

inclined, somewhat asymmetric; operculum conic; peristome perfect; annulus of two rows of cells; spores smooth.

This moss resembles *Scleropodium touretii* (Brid.) L. Koch but differs in the smooth seta, plants more regularly pinnate with branches in one plane, leaves broader, more deeply concave, tapering less, broader at apex, and more abruptly apiculate, and midrib shorter. The arrangement of the branches in one plane may not be evident on the smaller plants growing among grass in crowded tufts. Bruch, Schimper, and Gümbel (1854) and other authors have described the leaves as plicate, but under normal moist conditions they are very deeply concave but show no folds. When dry or under pressure they may appear to be plicate.

Pseudoscleropodium purum is common in Europe and was reported from the Caucasus by Brotherus (1925), from the Azores by Cardot (1897), and from the Azores, Madeira, Canary Island, and St. Helena by Geheeb (1910). Dr. H. Persson writes that there are two specimens from Jamaica in the herbarium at Stockholm. Sainsbury (1935) reported it from New Zealand as an introduced moss. Mr. K. W. Allison has found it in a number of places in New Zealand, and he considers it an introduced species. Brotherus (1925) listed it as from Japan, but Professor Noguchi tells me that he knows of no authentic record. Renauld and Cardot (1887) reported it from Miquelon Island on the east coast of North America near Newfoundland, but it is not included in Grout (1928).

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Basal leaf cells, × 365. 5. Cells of alar region showing recurved margin and decurrent cells, × 365.

CORTICOLOUS BRYOPHYTES ON PINUS IN FLORIDA

MILDRED JOAN ENGLE[1]

In the bryocoenological work that has been done to date in this country, the genus *Pinus* has been passed over rather quickly with the casual remark that apparently few species grow on its bark. By contrast, considerable emphasis has been placed on corticolous communities on various species of hardwoods. For example, *Magnolia* has been considered as supporting a large bryophyte population. Unpublished data supplied by Dr. Ruth S. Breen indicate that 22 species of bryophytes occur on *Magnolia grandifolia* in the mesophytic forests near Tallahassee, Florida. The present study was undertaken as an attempt to clarify the situation of *Pinus*. Collections were made in a 75 mile radius of Tallahassee, Leon Co., Florida.

Krueger (1912) in his discussion of the bark of *Pinus* described the outer, middle, and inner layers. In the present study only the outer bark, defined by him as all tissues lying outside the innermost layer of phellogen, is considered since bryophytes are surface-growing plants, and their rhizoids do not penetrate deeply. The variation in the way the bark sloughs off in *Pinus*, either in scales or plates, is a result of the position of the periderm. and its lateral extent. *Pinus* has a thickened sclerotic periderm. The bark sections made for this present study showed crescents of sclerenchyma, with points overlapping the neighboring crescents, encircling the stem beneath the cork layers. Under the relatively impervious cork and sclerenchyma layers is parenchymatous tissue.

Billings and Drew (1938) found that the moisture-holding capacity and the degree of porosity of bark affect the ease of attachment of bryophyte rhizoids. *Tsuga* bark was found to be almost impervious. It air-dried at a more rapid rate than any of the angiosperm barks tested and held the remaining moisture so that it was unavailable to plants. According to them, the available moisture in both the substratum and the atmosphere are of major importance in determining bryophyte growth, and the effects that seem to come from differences in light and temperature may instead be caused by varying moisture conditions.

[1] Morris Harvey College, Charleston, W. Va. Contribution from the Dept. of Biological Sciences, Florida State University, Tallahassee. The author was a National Science Foundation Undergraduate Research Participant during the summer of 1960, working with Dr. Ruth S. Breen.

Schornherst (1943) stated, "As pine bark sloughs off repeatedly and perhaps because of the accumulation of resin, corticolous bryophytes are rare on pines, and only those able to grow under diverse conditions, such as *Isopterygium (Plagiothecium) micans* and *Sematophyllum adnatum*, occur there." The suggestion that resin inhibits growth is based on the assumption that resin may possess antiseptic qualities.

In her work on cedar glades, Quarterman (1949) discovered that the continuous decortication of red cedar bark removes the older mats of mosses and exposes new bark to pioneering bryophytes. She also found that young cedar trees support a large number of mats in the earlier stages of succession while older trees develop mats representing the later stages.

Collections were made from *Pinus australis* Michx. (longleaf pine), *P. elliotii* Englm. (slash pine), *P. glabra* Walt. (spruce pine), and *P. echinata* Mill. (shortleaf pine). There was no evidence of any selectivity on the part of species of bryophytes for any of these species of *Pinus*. A total of 12 species of mosses and 11 species of liverworts comprise the following lists, which follow Grout (1940) and Evans (1940) as to nomenclature.

Mosses

Clasmatodon parvulus (Hampe) Sull.
Cryphaea glomerata Schimp.
Entodon seductrix (Hedw.) C. M.
Leucobryum albidum (Brid.) Lindb.
Leucodon julaceus (Hedw.) Sull.
Plagiothecium micans (Sw.) Paris
Schwetschkeopsis denticulata (Sull.) Broth.
Syrrhopodon floridanus Sull.
Syrrhopodon parasiticus (Sw.) Besch.
Syrrhopodon texanus Sull.
Thelia hirtella (Hedw.) Sull.

Liverworts

Cephalozia connivens (Dicks.) Lindb.
Euosmoloejeunea duriuscula (Nees) Evs.
Frullania kunzei L. & L.
Frullania squarrosa Nees
Lejeunea flava (Sw.) Nees
Leucolejeunea clypeata (Schwein.) Evs.
Leucolejeunea unciloba (Lindenb.) Evs.
Metzgeria myriopoda Lindb.
Microlejeunea bullata (Tayl.) Evs.
Plagiochila floridana Evs.
Riccardia latifrons Lindb.

In addition to the species reported here, Breen has found *Syrrhopodon incompletus* Schwaegr. in the cracks of *Pinus* bark. A check of the Florida State University bryophyte herbarium revealed that all the species listed herein had been collected from *Pinus* previously with the exception of *Thelia hirtella*, which is known from the barks of various species of trees. Each of the species found on *Pinus* bark was of itself no surprise since each

can grow under rather diverse conditions, but so great a number of species was unexpected. Probably the previously accepted idea that *Pinus* supports few species of bryophytes results from the relatively thin and inconspicuous mats occurring on its bark as compared with the dense growth of most of these species on hardwoods.

In xeric areas and on trees whose bark had recently sloughed off, *Microlejeunea bullata* was the only bryophyte collected; this suggests its probable rôle as a pioneering species. *Sematophyllum adnatum* and *Plagiothecium micans* form dense mats on the protected sides of trees in mesic areas and were collected from all but three trees. *Leucobryum albidum, Syrrhopodon floridanus, S. parasiticus, S. texanus, Thelia hirtella, Clasmatodon parvulus, Entodon seductrix, Leucodon julaceus, Schwetschkeopsis denticulata, Euosmolejeunea duriuscula, Metzgeria myriopoda, Riccardia latifrons,* and *Plagiochila floridana* were found only in very moist situations. In mesic areas *Lejeunea flava* was common in dense mats near the bases of trees and *Leucolejeunea unciloba* made thin mats on the trunks to a height of about nine feet. The collection of *Cephalozia connivens* came from the base of one tree, where a few strands of it were growing mixed with *Lejeunea flava.* The Frullanias grew in rather intricate, sometimes extensive, mats on the surface of the bark and in the cracks. In the more xeric areas *Frullania kunzei, F. squarrosa, Microlejeunea bullata, Lejeunea flava, Sematophyllum adnatum,* and *Plagiothecium micans* made up the bryophyte population on many trees; the growth, however, was in isolated strands rather than in mats.

Billings and Drew considered the acid reaction of *Tsuga* bark a growth-inhibiting factor. *Tsuga* bark had a range of pH 4.96 — pH 4.28. *Pinus* bark collected with the bryophytes listed in this paper was found to range from about pH 5.5 to pH 5.3, while *Magnolia* bark varied from about pH 6.4 to pH 6.1. Thus *Pinus* bark seems to fall in a continuous scale somewhere between the two extremes: *Tsuga,* impervious bark and acid reaction, and *Magnolia,* moist, sponge-like bark and slightly acid reaction.

While the barks on *Pinus* and *Magnolia* apparently support about the same number of species of bryophytes, it should be emphasized that only those species capable of withstanding rather xeric conditions are found on *Pinus. Magnolia,* on the other hand, has a few species which are apparently restricted to bark of a lower pH and a more spongy texture. *Jaegerina scariosa* (Lor.) Arz., *Schlotheimia rugifolia* Schwaegr., *Anomodon attenuatus* (Hedw.) Hüb., and *Haplohymenium triste* (Ces.)

Kindb. are characteristic of the lower trunks of *Magnolia,* but in no collection from *Pinus* did they appear.

Since this entire study was done in a period of ten weeks, it is obvious that this paper is only a preliminary report. Further collections in more varied habitats would doubtless expand the list of mosses and liverworts now known to occur on *Pinus.* No attempt was made in the present project to define any associations of bryophytes on *Pinus* bark.

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A SECOND AMERICAN RECORD FOR OREAS MARTIANA, FROM COLORADO

William A. Weber[1]

Summit Lake, a high alpine cirque lake at 12,800 feet on the northeast shoulder of Mount Evans in the Colorado Front Range, is a unique concentration point for alpine-arctic plants. Its great significance as a botanical area was indicated by the rediscovery here of *Phippsia algida* (Weber, 1952) and later discoveries of *Koenigia islandica, Saxifraga foliolosa, Juncus biglumis,* and other widely disjunct and characteristic arctic species for which Summit Lake marks the southernmost station in North America.

During the past few years, each visit to the lake has resulted in remarkable new finds of not only phanerogams but lichens and

[1] University of Colorado Museum, Boulder, Colo. Field work supported jointly by the University of Colorado Museum, University of Colorado Council on Research and Creative Work, and the National Science Foundation.

bryophytes as well. Although we have not been able to make a thorough-going investigation of the entire flora, attempts have been made to attract as many alpine and arctic specialists to the area as possible in the hope that their sharp eyes and greater experience with the flora might uncover more and more critical species. In the past few years the lake has been visited by Eric Hultén, Eilif Dahl, Mogens Westergaard, G. N. Jones, A. J. Sharp, Werner Lüdi, and others. In 1964 Summit Lake will be on the itinerary of the American Bryological Society's Foray.

During the late summer of 1960 we were fortunate to have two acute field men in the area, A. E. Porsild and Kjeld Holmen, both coming here from extensive experience in the far North. The occasion of the trip to Summit Lake at this time was an attempt to rediscover the station for *Campylopus schimperi* Milde, which Herman Persson had recently dissected in small quantity from the roots of a species of *Sagina* collected at Summit Lake in 1959 by Professor Hultén. The *Campylopus* turned out to be dominant, with *Polytrichum alpinum* and *Paraleucobryum enerve*, throughout the outlet area of the lake. While collecting this species in quantity, Holmen began to notice small dense mats of a yellowish-green moss occurring here and there among the other species, but always sterile. He remarked that this was very suggestive of *Oreas martiana*, but hesitated to make an identification because of the sterile material and the great disjunction in range which would be indicated. However, further search along a number of reticulating tussock-ridges surrounding a number of small ponds resulted in our discovery of several tufts of *Oreas* with the characteristic sporophytes on strongly recurved setae, leaving no doubt of their identity. Everywhere, however, the moss was mostly sterile, although the species appeared to be rather common in the outlet area.

Oreas martiana (Hoppe & Hornsch.) Brid. was first reported for North America only two years ago by Steere (1958) from Alaska. Shortly after this, Holmen (1960) reported it from two stations in North and East Greenland.[2] Most other records come from more continental areas in alpine regions of Eurasia. The

[2] Upon submitting the manuscript to *The Bryologist*, the writer learned from the editor of another North American record for this species. The following citation is given with his kind permission: CANADA. BRITISH COLUMBIA: Vicinity of Summit Lake, above small lake at mile 104 (above Fort Nelson), 58° 38′ N., 124° 40′ W., above timberline on S-facing slope of a high moraine, in moist soil pockets among grasses, occasional, alt. about 5500 ft., 26 July 1943, *Donovan S. Correll* 12,089 (CAN).

collection from the Rocky Mountains of Colorado,[3] therefore, establishes the typical pattern for the Western Hemisphere also.

Because Steere (1958) raised questions of the conspecificity of his Alaskan material with the Eurasian, it is most interesting to the discussion to have material from a truly alpine and continental area more comparable with the Eurasian localities. Steere felt that the yellow-green color of the Alaskan plants set them apart from the more generally brown Eurasian ones. The Colorado *Oreas* stood out from the surrounding moss flora in the field by its yellow-green color. However, close examination showed the color to be restricted to the most recent growth (about 2 mm. of the terminal parts), the tufts being brown below. Herbarium specimens do appear uniformly brown, but we suspect that this is a result of ageing and that the field appearance of *Oreas* is probably the same everywhere it occurs.

The habitat of the Colorado collection was also like that of the Alaskan one, on humus rather than on rocks. Our material, however, did form the typical deep and dense cushions typical of the European collections. *Oreas* reached its best development on narrow sod ridges formed by ice-shove from the surface of small outlet ponds. These ridges are often less than a meter across and are steep-sided. The ponds themselves support dense stands of *Calliergon sarmentosum*, and the ridges of turf support an interesting and varied moss flora including on the steep overhanging sides *Cirriphyllum cirrosum, Entodon orthocarpus, Scapania hyperborea, Solenostoma sphaerocarpum, Tayloria hornschuchiana*, and *Bryum pendulum*. The tops of the ridges are covered by *Polytrichum alpinum, Paraleucobryum enerve*, and *Campylopus schimperi*. The *Oreas martiana* most commonly occurs on the curving edge of the ridge between the horizontal surface and the steeply vertical sides. Although *Oreas* occurred most commonly on the level, periodically inundated ground of the outlet area, we did encounter it from time to time on the steeper tundra slopes above the lake, but more infrequently.

The leaves of the Colorado collection show the same erose-dentate margins as the Alaskan material. Steere has already showed that much of the Eurasian material has such leaves although the descriptions seem to ignore the point. The features of the sporophyte also agree with Steere's data. We therefore

[3] COLORADO. CLEAR CREEK CO.: Reticulate frost-raised margins of small tundra ponds, 12,800 ft., alt., outlet area of Summit Lake, NE. slope of Mt. Evans, 15 August 1960, *W. A. Weber, K. Holmen, & A.E. Porsild* B-4341 (CAN, COLO, DUKE, NY, S-PA).

agree with Steere that there is not much evidence for dividing *Oreas martiana* taxonomically.

The discovery of *Oreas* at Summit Lake emphasizes the fact that the area is not merely an isolated station for a few notable arctic-alpine phanerogams, but that we have here a complete assemblage of critical species in their expected ecological relationships reflected over the entire botanical (and in all probability zoological) spectrum. Among the bryophytes occurring with *Oreas, Campylopus schimperi* is only one of a number of highly disjunct species. Others include *Hydrogrimmia mollis,* which forms huge, sand-filled polsters in the cold streams arising from the snow-banks at the head of the lake, *Rhacomitrium canescens* and *R. fasciculare* at their only Colorado localities, *Hylocomium splendens* in its tundra aspect, *Polytrichum alpinum, Bryum teres, Andreaea rupestris, Grimmia incurva, Grimmia elatior, Cirriphyllum cirrosum, Entodon orthocarpus, Scapania hyperborea,* and other more widely distributed, characteristic alpine-arctic species. On neighboring McClellan Ridge, near Gray's Peak, is the only station known in the United States (exclusive of Alaska) for *Voitia nivalis* (Argentine Pass, 18 July 1886, *William Trelease*).

In addition to being one of America's unique botanical areas, Summit Lake is one of the most accessible. Only an hour's drive from the city of Denver, the mountain is served by a paved highway to the 14,261 ft. summit, open to traffic during the entire snow-free period. Summit Lake is provided with an automobile parking area and shelter house. Certainly such a place might well deserve the status of a National Monument to the Pleistocene ice ages. Unfortunately the lake receives no protection and, in fact, is already losing much of its botanical treasure because thoughtless fishermen drive off the paved road onto the rich meadows of the outlet in order to fish from the seats of their cars. Much of the outlet area has been converted by wheel tracks and beer cans into an unsightly gravel waste until it seems only a matter of time until this rich area so critical to a knowledge of American phytogeography will be lost to science.

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A NOTE ON THE SEXUAL CONDITION IN MNIUM SPINULOSUM[1]

NELS R. LERSTEN[2]

In most manuals *Mnium spinulosum* is described as synoicous, meaning that both antheridia and archegonia are mingled in the same inflorescence. Descriptions also indicate that long, filiform paraphyses are restricted to the inflorescence, and short, clavate paraphyses with yellow lower cells and hyaline upper cells occur only in the axils of the leaves below. Observations contrary to these descriptions were made in the summer of 1960, during the excising of leaves for a regeneration study. To determine the extent and frequency of differences from the described characters, samples from several Michigan populations of *M. spinulosum* were carefully examined over a period of six weeks.

Antheridia could be found in the axils of all leaves of the fertile stem except the innermost at the apex, those next to the archegonia. They were most abundant in the axils of the leaves in the terminal rosette. Archegonia occurred only in the inflorescence at the tip of the stem and were never mixed with antheridia. Three antheridia per axil was the common condition, with usually two or one in the lower leaf axils. In each axil there was an old, brown antheridium together with younger ones, indicating a temporal difference in formation in any one axil. On two occasions sperm release was noted from isolated antheridia, proving that they are functional.

The short, clavate paraphyses were rarely seen on fertile stems. On vegetative stems they occurred, 2-5 per axil, and 140-150 μ in length. Filamentous paraphyses, indistinguishable from those described as occurring only with archegonia in the terminal inflorescence, were found in almost every leaf axil on the fertile stems. These had only hyaline cells and were 2-7 times as long as the clavate type. They increased in size and in number from one to six progressively toward the apex. In many of the lower axils these paraphyses were found without accompanying antheridia.

The sexual condition in the plants examined is a paroicous one, with archegonia in a terminal inflorescence and antheridia in the axils of the leaves below. This may be one of the differences between the forms of the species which have been noted by

[1] Contribution from the University of Michigan Biological Station.
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various workers, including Grout (1903-10), who observed that the form found in the eastern United States is smaller than that from either Europe or the western United States, and also has only one sporophyte per gametophyte, whereas the other two forms have sporophytes clustered.

Dr. A. LeRoy Andrews, to whom grateful acknowledgement is given for examining some of the material, remarks (personal communication) that Limpricht's description gives only filamentous paraphyses and says nothing about either paraphyses or antheridia in the leaf axils. Limpricht described the European form, however.

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GROUT, A. J. 1903-10. Mosses with Hand-lens and Microscope. 416 pp. New York City.

AGRESTIA CYPHELLATA, A NEW GENUS AND SPECIES OF LICHEN IN THE USNEACEAE.

JOHN W. THOMSON[1]

Among some lichens collected in southern Saskatchewan during 1957 by Mr. Jan Looman and sent in for determination was some material of a short fruticose lichen with cyphellae over the branches and unripe lateral apothecia. Study showed that this material could not be placed in any genus or species in the current systems of classification. Pending discovery of well-developed spores, this lichen was left undescribed but was shown to several other lichenologists, none of whom recognized it. On return to Saskatchewan Mr. Looman collected more of this highly interesting lichen and obtained material with better developed apothecia. In the meantime, the same lichen was found in Colorado by Dr. William A. Weber. It was also found later in Montana by Mr. Looman. It appears to be an endemic of the western grasslands of North America.

Agrestia gen. nov. Thallus fruticosus, teretus, dichotomus, cyphellatus; medulla crebra; apothecia in lateribus, primum urceolata deinde adnata vel sessilia, lecanoroida; paraphyses moniliformes; sporae binae, simplices, ovales vel globosae, grandes.

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This genus can be placed in the Usneaceae by reason of its terete, fruticose branching thallus with a paraplectenchymatous outer cortex and the medulla densely agglutinated. The lecanorine lateral apothecia are also characteristic. The number of spores in the ascus is unique in the family. *Oropogon* has one muriform spore per ascus; the other genera have eight one- or two-celled spores. This genus has two large simple spores. Other features which are unique for the family are the moniliform paraphyses and the presence of true cyphellae, although other genera commonly have pseudocyphellae. There would also be strong justification for placing this genus in the Lecanoraceae. Its apothecia in the young stages resemble those of an *Aspicilia*. Further resemblances lie in the moniliform paraphyses and the close resemblance in form to some Aspicilias as *A. fruticulosa*. The epithecium does not give the characteristic "*Aspicilia*-green" reaction with HCl, however, and the cyphellae and number of spores are not those of an *Aspicilia*. The name is based on its presence in open grasslands.

Agrestia cyphellata sp. nov. Thallus fruticosus, teretus, dichotomus, esorediatus, sine isidiibus, luteo-olivaceus, cyphellatus; cyphellae albae; cortex paraplectenchymatus; genus algae *Trebouxia;* medulla crebra; apothecia in lateribus, primum urceolata, deinde adnata vel sessilia; discus fusconiger vel pruinoso-griseus, margine integer; paraphyses moniliformes non capitatae; asci clavati; sporae binae, simplices, ovales vel globosae, grandes. Conceptacula pycnoconidialia non observata. Typus in herb. Univ. Wisconsinensis depositus; *Jan Looman* 657, vic. Maple Creek, Saskatchewan, 1957.

The thallus is short-fruticose, about 1 cm. in height, forming small, rounded tufts with the main branches up to 2 mm. thick but rapidly decreasing in size, the branching very *Cladonia*-like, dichotomous to partly sympodial, the tips blunted to partly nodulose. The surface is a dull orange-greenish (Seguy: *Code Universal des Couleurs* no. 223), unchanged when wet, cyphellate with true cyphellae which are whitish and scattered (there are also white spots where some of the branches have been broken off), esorediate and lacking isidia. The medulla is densely agglutinated, yet not forming a central strand as in *Usnea*. The lateral apothecia are at first aspicilioid and are in broadly swollen parts of the main stems, later becoming open-disked, adnate and even stipitate. The margin is entire and lecanoroid; the disk is up to 4 mm. broad and is chocolate-black and dull, or else with a gray pruina. The broadly clavate asci contain two subspherical

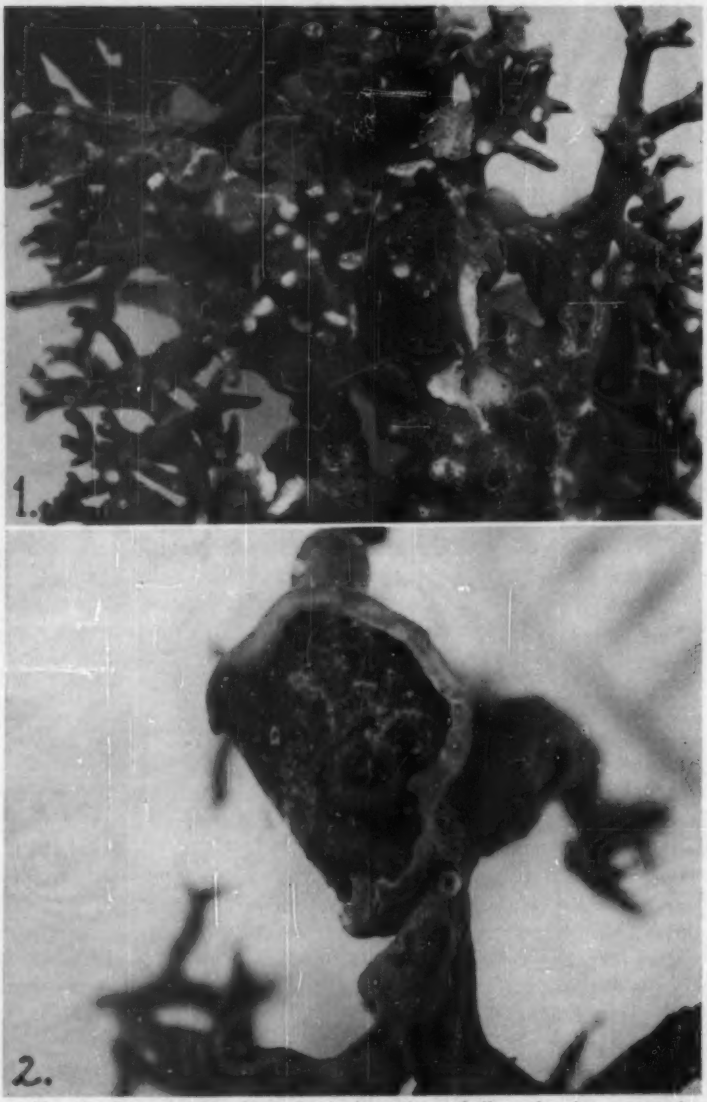

FIG. 1. Central part of a tuft of *Agrestia cyphellata* showing young developing apothecia, some cyphellae and many white spots of broken branches. FIG. 2. An old apothecium of *Agrestia cyphellata*, the branch also showing cyphellae.

spores which are quite large, 24 μ broad; the paraphyses are branched and septate with the outer cells markedly moniliform. The algal layer is glomerulate, not continuous; the algae are *Trebouxia* sp.

The outermost part of the cortex is brown, amorphous to prosenplectenchymatous, 10-12 μ thick; the outer cortex proper is 21 μ thick, brown and dense, paraplectenchymatous, 2-3 cells thick; the inner cortex is 42 μ thick, clear, with the hyphae slightly radially oriented but densely agglutinated. The algal layer is of widely scattered glomerules of 30–70 μ to a layer 250–300 μ thick, with the hyphae among them looser and more like those of the medulla than those of the cortex. The central medulla is very dense, of agglutinated but not paraplectenchymatous hyphae, rather indurated, in a layer about 600 μ in diameter, the hyphae 10-14 μ in diameter with the walls varying from 2 μ to most of the thickness of the hyphae. The hypothecium is about 50 μ thick, densely paraplectenchymatous, not extending clearly to the margins of the disk; the hymenium is 140 μ thick, hyaline, the paraphyses branched, septate, 2-3 μ thick with the outer cells moniliform and 4 μ thick; the asci are 60-77 × 28-32 μ, broadly clavate; the two spores are subspherical, 21-24 μ, simple, hyaline. In the ascus they give the appearance of a single 2-celled spore.

No identifiable chemical content was found.

The type, deposited in the herbarium of the University of Wisconsin, is *Jan Looman*, 657, Saskatchewan, Canada, near Maple Creek. The data provided by Mr. Looman include: LOCALITY: Section 14, N.E.¼, Township 9, Range 28 W., on a Haverhill loam soil with 25% sand, 43% silt, 32% clay and 2.4% organic matter. The moisture equivalent was 29.5% and the pH 8.8. The vegetation was typical of the so-called 'Burn-out' soils in the sociological classification *Schedonnardetum paniculati* characterized by the occurrence of *Schedonnardus paniculatus, Aster pulverulentus* and *Atriplex nuttallii*. The altitude was 2950 ft. on a level, probably alluvial plain. The collections were made in April, 1957.

After showing the type material to Dr. William Weber of the University of Colorado, I received three more collections of this highly interesting lichen, all from Colorado, as follows: MONTEZUMA Co., on thin red soil over sandstone near the rim of the canyon, top of Wetherill Mesa, above Long House, Mesa Verde National Park, 7000 ft. alt, May 30, 1959, *W. A. Weber* S18,622; BOULDER Co.; on bare soil with *Dermatocarpon, Toninia caeruleonigricans*, etc., between patches of *Selaginella densa*, over

arkosic horizontal rocks, base of Steamboat Mt., just west side of Blue Mt. road, about 3 mi. NW. of Lyons, 6000 ft. alt., Apr. 27, 1959, *W. A. Weber* & *S. Shushan* S18,592; a second collection from nearly the same locality but 2 mi. NW. of Lyons, Mar. 12, 1959, *W. A. Weber* & *S. Shushan* S18,592 [sic].

During the field season of 1960 Mr. Looman, alert to the need for more information on the range of this species, found it in Montana, 5 mi. north of Wolf Point, on eroded hilltop in grassland, no. 60-08-1. Additional localities collected by Mr. Looman in Saskatchewan show this to be a wide-ranging species across the southern part of the province, numerous collections being made near Stewart Valley, Swift Current, Maple Creek, East End, Cadillac, Val Marie, Assiniboia, Milestone, Carmichel, and Weyburn. This lichen most evidently needs to be sought across the adjacent northern grasslands of the United States as well.

I am much indebted to Mr. Jan Looman and to Dr. William Weber for freely placing at my disposal the material which they had collected. I am also indebted to Prof. Paul MacKendrick for assistance with the Latin diagnoses.

THE LICHEN ASSOCIATION[1]

VERNON AHMADJIAN[2]

The problem of what constitutes the lichen association and how it begins has not been satisfactorily elucidated on the basis of investigations. What happens to the countless number and varieties of lichen spores which fall on suitable substrates after being discharged from the practically ubiquitous lichen fruiting bodies? The usual explanation is that the spores germinate, sending out hyphal tubes which must then make contact with a suitable algal species, within a certain amount of time, or expire. Such an explanation is too simple. In the first place, it implies that the fungal germ tubes actively seek out their algal symbionts, which they do not, and secondly it seems to suggest that suitable free-living algal species are abundant in nature, which they are not.

The algal genus *Trebouxia* is the most common algal symbiont of lichens, forming the phycobiont of the vast majority of all

[1] Portions of this investigation were supported by a National Science Foundation Grant (NSF-G13049).

[2] Dept. of Biology, Clark University, Worcester, Mass.

known lichen species. Yet the total number of free-living forms of this genus described to date is two: namely, *Trebouxia arboricola* de Puym. (de Puymaly, 1924; Ahmadjian, 1959) and *Cystococcus* (= *Trebouxia*) *cladoniae-endiviaefoliae* var. *parva* Raths (Raths, 1938). It has been shown that many different species of *Trebouxia* form the symbionts of various lichens (Chodat, 1913; Warén, 1918-19; Jaag, 1929; Raths, 1938; Ahmadjian, 1959). How can this fact be correlated with the seeming paucity of free-living strains of *Trebouxia*? Perhaps there is only one or even two true free-living *Trebouxia* species, and all the lichen phycobionts are merely biotypes or ecological variants which have undergone modifications and selections through their association with the mycobiont. The different algal strains found in specimens of the same lichen species could be rationalized as being caused by differences of lichenic acids in the morphologically identical lichens. Such an argument, however, breaks down when the same algal type (morphologically and physiologically) is shown to be the symbiont of different lichen species (Raths, 1938; Zeitler, 1954; Ahmadjian, 1959), indicating the lack of a strong fungal influence on the algal symbiont.

The question of what constitutes a free-living species of *Trebouxia* is hard to answer. So many lichens fragment easily and produce soredia and isidia which are easily distributed by wind and rain that one would expect to find such small lichenized groups practically everywhere. This, in fact, seems to be the case. In an investigation of numerous algal covers on bark, I frequently noted a small percentage of *Trebouxia* cells mixed among the predominantly pleurococcoid-type of algae. Algal covers of this type, moreover, invariably contained fungal hyphae which, in many instances, clasped the various algal cells, including the *Pleurococcus* cells in a true lichen-like fashion, a fact noted also by Tengwall (1924), Schmid (1933), Thomas (1939), and Quispel (1943-45). Quispel showed the similarity between fungi of this type and true lichen fungi. Should these *Trebouxiae* then be classed as true free-living types or do they merely represent the asexual structures mentioned above which because of unfavorable conditions failed to develop fully, or are in the very early stages of lichen formation? Numerous investigations of algal covers in the Uppsala region of Sweden by the author failed to reveal a single predominantly trebouxioid algal cover; this is in contradiction to Hedlund (1949), who claimed that *Protococcus xanthoriae* (= *Trebouxia*) was widespread and common on tree trunks in the same region. Petersen (1915) noted cells of

Trebouxia mixed among other algae in Denmark; de Puymaly (1924) noted the same condition in France. Petersen (1928) had considerable difficulty in finding free-living species in Iceland. Jaag (1929) was unsuccessful in his attempts to find free-living species, and Quispel (1943-45) noted the absence of free-living *Trebouxia* in the Netherlands. Treboux (1912), however, found that algal covers on bark in southern Russia consisted mainly of this genus. Possibly what he saw were species of leprose lichens.

Recent cultural experiments made by the author have shown that the mycobionts of *Lecanora dispersa* (Ahmadjian, 1959) and of *Acarospora fuscata* and *Cladonia rangiferina* (Ahmadjian, unpublished) do not show a directed growth toward the separated cells of their algal components, but rather certain hyphae form the "lichenized" associations after accidental contact with the algal cells. Bonnier's experiments on lichen synthesis (1888a,b, 1889) indicated this same thigmatropic response of the lichen fungus. In several instances, Bonnier introduced different types of algae in a lichen fungal culture and found that the hyphae attached themselves to the algal cells. In an experiment using *Vaucheria sessilis*, Bonnier noted that the germinating hyphae of *Lecanora subfusca* grew all around the algal filament; he observed also cultures in which the lichen fungi made numerous intimate contacts with moss protonemata. He described an experiment in which small grains of sand and tiny glass rods were seized and encircled by the lichen fungal components. Thomas (1939) noted a lack of specificity of the mycobiont to its algal partner in his attempts at synthesis. In preliminary cultural experiments using the fungal margin of *Pertusaria globulifera*, the author noted that the hyphae readily accepted and formed "lichenized" contacts with introduced algal cells of the *Physcia stellaris* phycobiont; *in situ* examinations of the phycobionts of the two lichens seemed to show morphological differences. These experiments suggest that the lichen fungi are not discriminatory toward their algal components. On the basis of this fact and the relative scarcity of free-living *Trebouxia*, we can perhaps obtain a clearer understanding of what occurs in nature.

The germinating spores and marginal hyphae of established lichens undoubtedly encounter cells of *Pleurococcus vulgaris* since this is perhaps the most widely distributed alga in the world. Apparently, however, this algal species cannot withstand the encroachments of the fungus; no lichen has yet been described with this species as its phycobiont. One possible exception to this is *Bacidia chlorococca*, a lichen lacking a well-developed cortex.

What happens to this alga? The above investigations seem to indicate that the lichen fungi make numerous, close contacts with these *Pleurococcus* cells; examination of algal covers shows many of these algae in a "lichenized" state. Moreover, microscopic investigations of the borders of fully-developed lichens growing on algal covers, for example, *Pertusaria* and *Lepraria,* will reveal typical packets of the *Pleurococcus* algae, many of which are dead or dying. Dead *Trentepohlia* filaments are also found among the fungal hyphae. The fact that most of these algae do not survive is attested to by the general lack of multiplicity of algal genera in a lichen thallus. The lethal action of the mycobiont on these algae can be attributed either to the direct action of the fungus or to the consequent reduction of light intensity to a point below the minimal level for the algae. Many lichens or lichen fungi produce highly pigmented compounds which must greatly reduce the light intensity reaching the algal cells. The *Trebouxia* cells can obviously withstand such fungal contacts better, even though their initial mortality rate may be rather high. Many dead algal cells of this genus are also seen among the advancing fungal hyphae of a lichen. The *Trebouxia* algae seem also to be favored by having a rather low optimal light intensity (personal observations and also experiments carried out with the phycobiont of *Buellia punctata* by Ralph E. Lewin, Woods Hole, Mass.), and they can live almost as nicely saprophytically in the complete absence of light. The main advantage that the lichenized *Trebouxia* cells gain from the lichen fungus is the removal of competitive algae, such as *Pleurococcus,* which hinder or retard their full development.

The possibility exists that the germinating or marginal hyphae of a lichen fungus may encounter several different forms and varieties of *Trebouxia* during their growth, indeed even incorporate the algae from isidia, fragments or soredia from other lichens. It should not be assumed that a fully developed lichen contains only one type of *Trebouxia.* Thomas (1939) showed that different physiological types of *Trebouxia* do occur in the same lichen thallus; he did not attempt a morphological differentiation of these strains.

Thus, with regard to the phycobiont of lichens, it appears to be not a case of the lichen fungus seeking out a suitable partner, but rather it's a question of which alga can survive fungal association. The algal genus *Trebouxia* because of its slow growth and low optimal light intensity seems well suited to its lichenized fate.

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REVIEWS

Z. Pilous & J. Duda: *Klíč k určování mechorostů ČSR.* 569 pp. Pl. 1-94. Československá Akademie Věd, Praha. 1960. Kčs 41,50.—This book, written in Czech, is a manual (and apparently a good one) of the Musci and Hepaticae of Czechoslovakia, presented in the traditional form—keys, descriptions, and illustrations. The latter, though attractive and no doubt useful, are done with Spartan simplicity and a formalized style which is not effective in portraying more intimate details of diagnostic value. The systematic portion of the book is prefaced by essays on morphology (with orginal illustrations), distribution, and herbarium techniques, as well as a glossary and a bibliography. Foreigners will find it useful to own this book for its drawings and also its wealth of floristic information. —H. Crum.

Bronislaw Szafran: *Mchy (Musci).* 449 pp. Pl. 1-32. (Flora Polska; Rosliny zarodnikowe Polski i ziem Ościennych. Vol. 1.) Polska Akademia Nauk Instytut Botaniki, Warzzawa. 1957. Zł 69.—Written entirely in Polish, this work is obviously limited in its usefulness to foreigners. It is a manual for identification, with the usual keys, descriptions, and brief statements of ecology and distribution. Essential diagnostic features are illustrated by simple but effective drawings. The book is printed on a fairly good grade of paper which is, however, too soft for the constant use which a manual receives. The binding, in cloth, is weak and flimsy, as usual in Slavic publications. Why?—H. Crum.

Herbert Weymar: *Buch der Moose. Standort, Morphologie und Systematik der in Deutschland verbreitetsten Laub- und Lebermoose.* 308 pp. Fig. 1-229. Tab. IA-IXA, IB-IXB. Neumann Verlag, Radebeul and Berlin. 1958. DM 12.—. —A most attractive book on mosses and liverworts, Weymar's *Buch der Moose* is highly recommended for use by beginning bryologists in North America, especially in the East, where the genera and the common species are much the same as in Germany. It is not at all necessary to know German in order to make effective use of this book, which employs a picture book technique. The illustrations, by Kurt Schulze, are remarkably good and have caught the "look" of the living plants. In addition to habit sketches a few gross diagnostic features (such as leaf shape) are shown in many instances. For those who read German, the family characteristics, given in an outline form and the tables for identification of species, by ecological as well as morphological means, will be useful but cumbersome. The text is over-organized and therefore too much bother for the casual student, and an introductory generic key would have improved the book tremendously. I like better the extended, illustrated keys used by Gams in the *Kleine Kryptogamenflora* or Conard in *How to Know the Mosses.* This book is, of course, aimed at a less informed public, such as children and unspecialized nature lovers. Such persons usually shy away from keys, particularly long, unworkable ones. Would they not also take fright at the formidable tables which replace them here? —H. Crum.

Karl Bertsch: *Moosflora von Südwestdeutschland.* Ed. 2. 234 pp. Fig. 1-122. Eugen Ulmer, Stuttgart. 1959. DM 10.—. —The second edi-

tion of the *Moosflora* by Bertsch, is nicely printed on a much better grade of paper than the previous edition of 1949, and it includes a greater area (all of southwestern Germany) and a larger number of species: 762 mosses and liverworts. The book is organized into a series of taxonomic keys to families, genera, and species, with simple illustrations strategically located among them. Several supplementary keys, divided according to ecological provenience, follow at the end. The illustrations, though useful, do not compare favorably with those in Gams' *Kleine Kryptogamenflora*. They have been reduced too greatly, and cellular details, when shown, are too stylized to aid in comparisons. This book would occasionally be useful on this continent, but it offers little not already treated more extensively or intensively elsewhere. It is not suitable for veriest beginners or rank amateurs.—H. Crum.

W. B. Turrill, Editor: *Vistas in Botany. In* International Series of Monographs on Pure and Applied Biology. Division: Botany, vol. 2. xv + 547 pp. Illus. Pergammon Press, N.Y. 1959. $17.50.—This book, handsomely printed and bound, consists of 18 essays covering all the major disciplines of botany (taxonomy, anatomy, biochemistry, ecology, plant geography, etc.) One essay is in German; the remainder are in English. A mention of some of the authors—J. Braun Blanquet, W. B. Turrill, D. G. Catcheside, G. L. Stebbins, and F. W. Went—speaks more eloquently than I could on the excellence of this review of the past and insight into the future of botanical research. Most of the book makes rather heavy reading, to be avoided at bedtime, but Ph.D. candidates cramming for "prelims" will find it most useful. It is strongly recommended for all university libraries, but it is too broad in scope and too expensive for most of us to own personally. Paul Richards' chapter on Bryophyta (pp. 387-420) is quite readable and very interesting. Prof. Richards has a detailed knowledge of all phases of recent bryological research, presents them in an interesting and informative fashion, and relates them to one another in such a way that the mind naturally gains some of the author's own vistas. Required reading for all bryologists.—H. Crum.

RECENT LITERATURE ON LICHENS—35[1]

William L. Culberson[2]

Aasamaa, H. Perekondade *Cetraria* Ach. ja *Cornicularia* Ach. tunnustest liigil *Cornicularia odontella* Ach. Loodusuurijate Seltsi Aastaraamat, Eesti NSV Teaduste Akad. [Tallinn] 1956: 289-294. 6 fig. 1956. [Russian summary.]

Almborn, O. Lavfloran på Hallands Väderö—en översikt. [The lichen flora of Hallands Väderö—a survey.] Skånes Nat. 46: 69-82. 7 fig. 1959. [Many spp.]

Anderson, L. E. Personal reflections on Alexander W. Evans. The Bryologist 63(2): 84-88. 1 portrait. 1960.

[1] The names of new taxa from the Americas are marked with an asterisk (*).

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ASAHINA, Y. Lichenologische Notizen (§ 160-163). Jour. Jap. Bot. 35(4): 97-102. 4 fig. 1960. [New: *Parmelia* (Hypotrachyna) *metarevoluta* n. sp., *Lasallia asiae-orientalis* n. sp., *L. mayebarae* (Sato) n. c.]

AWASTHI, D. D. On a collection of macrolichens by the Indian expedition to Cho-Oyu, East Nepal. Proc. Indian Acad. Sci. 51B(4): 169-180. 1960. [38 spp.]

CORNER, E. J. H. A new European clavaria: *Clavulinopsis septentrionalis* sp. nov. Friesia 5(3-5): 218-220. 2 fig. 1956. ["The hyphae... may grow in intimate contact with soil-algae..."]

CRUNDWELL, A. C. A lichen new to Scotland. Glasgow Naturalist 17(6): 279. 1956. [*Sticta sinuosa* Pers.]

CULBERSON, W. L. *Parmelia ulophyllodes* (Vain.) Savicz in the North American lichen flora. Jour. Elisha Mitchell Sci. Soc. 76(1): 141-142. 1 tab. 1960.

DAHL, E. Analytical Keys to British Macrolichens. 37 unnumbered pp. Cambridge, England. 1952. [Mimeographed keys to many genera and spp. Available from the Botany School, Downing Street, Cambridge for 2 shillings.]

DOPPELBAUR, H. Ein Beitrag zur Anatomie und Entwicklungsgeschichte von *Dermatocarpon miniatum* (L.) Mann. Nova Hedwigia 2: 279-286. Tab. 47-48. 1960.

DUNCAN, U[RSULA] K. A survey of the bryophytes and lichens of "The Burn," Kincardine. Trans. Bot. Soc. Edinburgh 39: 62-84. 1 map. 1960. [About 175 lichens.]

EYERDAM, W. J. Lichens new to the State of Washington. The Bryologist 63(2): 107-110. 1960. [42 spp.]

FOLLMANN, G. Pioniere und Kletterer. Orion [München] 12(5): 397-401. 1957. [Popular article on lichens.]

———. Pilze mit Nutzpflanzen. Kosmos [Stuttgart] 55 (1): 28-34. 9 fig. 2 pl. of 12 colored fig. 1959. [Popular article.]

[GLADYSHEV, B. N.] [Distribution of easily hydrolyzed hexosamine-containing substances in plants.][a] [Biokhimiia] [Moskva] 20(6): 696-700. 3 tab. 1955. [Data on 4 lichens: tab. 2, p. 697.]

GLANC, K. Notatki lichenologiczne z Roztocza. [Lichenological notes from Roztocze.] Poznańskie Towarzystwo Przyaciół Nauk, Wydział Mat.-Pyzyrodniczy, Prace Komisji Biol. 17(7/2): 39-52. 1958. [91 spp.]

[GORCHAKOVSKII, P. L.] [High mountain vegetation of Yaman-Tau, the highest peak of Southern Ural.][a] [Bot. Zhurn., Akad. Nauk SSSR] 39(6): 827-841. 8 fig. 1954. [Several lichens mentioned. In Russian.]

HALE, M. E. JR. Alexander W. Evans and lichenology. The Bryologist 63(2): 81-83. 1960. [With a bibliography of Evans' papers on lichenology.]

HALICZ, B. L'application de la méthode dentritique aux recherches sur la répartition des lichens dans la région de Łódź. Bull. Soc. des Sci. et des Lettres de Łódź, Cl. III des Sci. Mat. et Nat. 10(10): 1-8. 3 tab. 1959. [91 spp.]

HARDER, R. & E. UEBFLMESSER. Über die Beeinflussung niederer Erdphycomyceten durch Flechten. Ark. für Mikrobiol. 31(1): 82-86. 2 tab. 1958. ["Soil phycomycetes can be cultured very rarely from the thin

[a] Names and title transliterated and translated respectively from the Russian.

soils under lichens. Experiments show that the lichens are able to inhibit the growth of these fungi."—T. D. Brock.]

HÄYRÉN, E. Nagra lavar och mossor från Lemsjöholm. Mem. Soc. Fauna et Flora Fenn. 30: 21-22. (1953-1954) 1955.

———. *Parmelia acetabulum* i Finland. *Ibid.* 32: 143-144. (1955-1956) 1957.

[KAREV, G. I.] [On moisture capacity of forage lichens.][a] [Bot. Zhurn., Akad. Nauk SSSR] 40(5): 705-709. 4 tab. 1955. [Study of 9 spp. In Russian.]

KLEMENT, O. Zur Flechtenvegetation der Achtermannshöhe im Harz. Ber. Naturhist. Gesell. [Hannover] 104: 1-7. 1 pl. 1959. [Many spp.]

KRAWIEC, F. Porosty Wysoczyzny Kaliskiej. [Lichens de la plaine diluviale de Kalisz.] Poznańskie Towarzystwo Przyjaciół Nauk, Wydział Mat.-Przyrodniczy, Prace Komisji Biol. 17(1): 37-54. 1 map. 1955. [142 spp. French and Russian summaries.]

KUROKAWA, S. On lichen specimens collected by H. Koidzumi. Jour. Jap. Bot. 32(7): 222-224. 1957. [In Japanese.]

———. *Anaptychiae* (lichens) and their allies of Japan (3). *Ibid.* 35(3): 91-96 [not "94"]. 1 fig. 1 pl. 1960. [3 spp. New: *A. fulvescens* (Vain.) n. stat. with v. *rottbollii* (Vain.) n. c.]

LAMBION, J. & G. PARMENTIER. *Parmelia andreana* Müll. Arg. et *Parmelia revoluta* Flk. en Belgique. Bull. Soc. Royale de Bot. de Belgique 92 (1-2): 229-235. 1960.

MAJERNÍKOVÁ-HLAVÁČKOVÁ, JELENA. Lišejníky ovocných stromů. [Lichens on fruit trees.] Sborn. Československé Akad. Zemědělských Ved Rostlinná Výroba [Ročník] 3(2): 141-156. 3 fig. 3 tab. 1957. [28 spp. "Indirectly the lichens harm the tree by promoting the development of parasitical fungi..."—English summary.]

[MAKAREVICH, M. F.] [Main characteristics in the distribution of lichens in the plant communities of the Carpathians within the Soviet Union.][a] [Bot. Zhurn., Akad. Nauk SSSR] 43(6): 781-787. 1958. [Characteristic spp. of the communities of the various altitudinal zones. In Russian; English summary.]

MEES, G. La végétation épiphytique de la Vallée de la Semois en relation avec la végétation forestière. Bull. Soc. Royale de Bot. de Belgique 92 (1-2): 77-95. 3 fig. 1960. [Several lichens.]

[MOISEEVA, I. N.] [New evidence on the fermentative characteristics of lichens.][a] [Bot. Zhurn., Akad. Nauk SSSR] 43(1): 29-37. 4 fig. 4 tab. 1958. [Study of the extracellular enzymes of 12 spp. In Russian; Engiish summary.]

MUSSO, H. Die Trennung des Orceins in seine Komponenten (II. Mitteil. über Orceinfarbstoffe). Chem. Ber. 89(7): 1659-1673. 4 fig. 4 tab. 1956. [Components of orcein by chromatography.]

PROCHÁZKA, Ž. Phenole und aromatische Säuren. Pp. 311-341 *in* I. M. Hais & K. Macek, "Handbuch der Papierchromatographie. Band I. Grundlagen und Technik." xxiv, 860 pp. 242 fig. VEB Gustav Fischer Verlag. Jena. 1958. [Review paper. Rf values for lichen substances.]

RAJAGOPALAN, T. R. & T. R. SESHADRI. Chemical investigation of Indian lichens XXI. Occurrence of fallacinal in *Teloschistes flavicans*. Proc. Indian Acad. Sci. 49A(1): 1-5. 1959. [The sp. contained physcion and fallacinal..." and did not contain any appreciable amount of teloschistin."]

RANGASWAMI, S. & V. SUBBA RAO. Chemical components of *Usnea florida*

Wiggs. Indian Jour. Pharm. 17: 70. 1955. [Usnic, salazinic and stictic acids isolated from Indian material.]

REIMERS, H. Zweiter Nachtrag zur Moosflora des südlichen Harzvorlandes II. Feddes Repertorium Spec. Nov. Reg. Veg. 59(2): 117-140. 1956. [5 spp. Long discussion of *Fulgensia bracteata* (Hoffm.) Räs.]

SCHADE, A. Über *Cladonia Rappii* Evans. Ihr Vorkommen in der Oberlausitz und im übrigen Sachsen sowie ihre sonstige Verbreitung. Nova Hedwigia 2: 407-423. 1 tab. 1960. [New: *C. r.* f. *evolutoides* n. f., f. *cervicornioides* n. f.]

SCHUSTER, R. M. Alexander W. Evans—an appreciation. The Bryologist 63(2): 73-81. 2 portraits. 1960. [With a bibliography of Evans' bryological papers.]

SIERK, H. A. Notes on Tennessee lichens. Tennessee Acad. Sci. Jour. 33 (2): 148. 1958. [Abstract.]

STEVEN, H. M. & A. CARLISLE. The Native Pinewoods of Scotland. xvi, 368 pp. 39 fig. 20 pl. 10 tab. Oliver & Boyd. Edinburg. 1959. [About 25 lichens, pp. 327-328.]

SVRČEK, M. Lichenologické příspěcky z Povltaví a Středních Čech. Časopis Národního Mus., Oddíl Přírodovědný 125(2): 186-192. 1956. [14 spp.]

SZATALA, Ö. Neue Flechten. V. Ann. Hist.-Nat. Mus. Natl. Hungarici, ser. nov. 7: 271-282. 1956. [New: *Placidium ádámi borosi* n. sp.; *Chaenotheca chrysocephala* f. *umbellata* n. f.; *Arthonia dispersa* f. *subparallela* n. f.; *Melaspilea* (Holographa) *graeca* n. sp.; *Gonohymenia hungarica* n. sp.; *Catillaria atropurpurea* f. *ecrustacea* n. f.; *Pertusaria leucosora* f. *balatonica* n. f.; *Aspicilia inundata* n. sp.; *Lecanora croatica* n. sp.; *L. dispersa* f. *rimiseda* n. f.; *L. subfuscata* f. *lignicola* n. f.; *Squarmaria albomarginata* f. *imbricata* n. f.; *S. radiosa* f. *nigromarginata* n. f.; *Lecania erysibe* f. *orbicularis* n. f.; *Caloplaca cerinella* f. *aggregata* n. f.; *C. lactea* f. *densa* n. f., f. *subimmersa* n. f.; *C. variabilis* f. *densa* n. f., f. *geographica* n. f.; *C. balatonica* n. sp.; *C. gialolechiaeformis* n. sp.; *C. vitellinaria* n. sp.; *Gasparrinia granulosa* f. *flavovirens* n. f.; *Xanthoria aureola* f. *fulva* n. f., f. *vitellina* n. f.; *X. candelaria* v. *discolor* n. v.; *Diplotomma ambiguum* f. *olivascens* n. f., f. *pruinosum* n. f., v. *agglomeratum* n. v., v. *ochraceum* n. v.; *D. hungaricum* n. sp. with v. *rimicola* n. v.; *Diploicia canescens* v. *isidioidea* n. v.; *Rinodina fusca* f. *dispersa* n. f.; *R. pyrina* f. *depauperata* n. f.; *R. teichophila* f. *despersoareolata* n. f. Key to all spp. of *Diplotomma*.]

TAVARES, C. N. Acerca de uma carta inédita do Dr. F. Welwitsch. Portugaliae Acta Biol. 6B(3): 335-342. 4 pl. 1959. [Concerning lichens.]

———. Lichens from Spain I. Rev. da Fac. de Ciên. de Lisboa, 2.ª ser. 7C(1): 53-74. 1959. [100 spp. New. *Acarospora tavaresiana* Magn. n. sp. A bibliography of Spanish lichenology of some 140 references.]

[THOMSON, J. W.] Lichenes Arctici. 10 unnumbered pp. [Madison, Wisconsin. 1960.] [Labels for 60 exsiccat numbers from the American arctic. Processed publication.]

ULLRICH, H. & O. KLEMENT. Icones Lichenum Hercyniae. Fasz. I. 4 unnumbered pp. 12 photographs. Langelsheim (Harz). 1960. [11 spp. To be continued.]

VERSEGHY, CLARA. Studien über die Gattung *Ochrolechia*. I. Ann. Hist.-Nat. Mus. Natl. Hungarici, ser. nov. 7: 283-298. 1956. [Treatment of 23 spp.; thallus color reactions; key. New: *O pergranulosa* (Räs.) n. c.; *O. havaiensis* (Räs.) n.c.; *O. androgyna* f. *leprosa* (Nyl.) n. c., f. *tatrica*

(Gyel.) n. c., v. *saxorum* (Oeder) n. c., f. *granulosa* (Räs.) n. c.; *O. papillata* (Räs.) n.c.; *alboflavescens* v. *turneri* (Sm.) n. c., f. *subfarinosa* n. f.; *O. isidiata* (Malme) n. c.]

VĚZDA, A. Flechten der tschechoslowakischen Karpaten III. Ergebnisse der lichenologischen Durchforschung im tschechoslowakischen Teile der Karpaten im Jahre 1958. Biológia [Bratislava] 15(3): 168-182. 1 fig. 1960. [About 100 spp. New: *Gyalecta subscutellaris* n. sp.]

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NEWS AND NOTES

NARINDER CHOPRA, a graduate student in bryology at the University of Tennessee, died suddenly at Knoxville on December 31. He was born in Pakistan on August 28, 1932.

WALTER WATSON (1872-1960), author of the *Census Catalogue of British Lichens*, died recently. His lichen herbarium was left to Kew, his bryophyte collections and library to the British Museum.

On June 1 GEORGE A. LLANO left his position with the Commission on Polar Research to become biology specialist in the Science and Technology Division of the Library of Congress, Washington, D. C.

WILLIAM C. STEERE and Mrs. Steere left New York on Thanksgiving Day to attend the Fiftieth Anniversary Celebration of the Botanical Society of Argentina at Tucumán. They planned to visit several botanical gardens on the way home, at Montevideo, Rio de Janeiro and São Paulo.

I. MACKENZIE LAMB visited the U.S. Naval Air Facility at McMurdo Sound, E. Antarctica, in October, at the invitation of the National Science Foundation, to consult with U.S. Antarctic Research Program biologists stationed there on the intensification of botanical collecting activities. Advantage was taken of a stop-over in New Zealand to study *Stereocaulon* in the field.

A. J. SHARP plans to teach bryology and lichenology again at the University of Michigan Biological Station. Details can be had from Dr. A. H. Stockard, Dept. of Zoology, University of Michigan, Ann Arbor. Dr. Sharp will also teach bryology July 17-22 in the Botanical Society of America summer institute for college teachers. Further details are available from Dr. Adolph Hecht, Washington State University, Pullman.

A. J. SHARP has been elected president of the American Society of Plant Taxonomists.

RUDOLF M. SCHUSTER planned to leave Amherst in January 1961 for Buenos Aires via Puerto Rico and Trinidad. From August 1961 to May 1962 he will study at the University of Dunedin, New Zealand, on a Fulbright fellowship.

WINONA H. WELCH has received a $400 grant-in-aid from Sigma Xi to assist in her monographic study of the Hookeriaceae.

JOYCE HEDRICK JONES recently retired from her duties as curator of lichens at the herbarium of the University of Michigan.

MARGARET FULFORD spent six weeks in 1960 at the Conservatoire et Jardin Botanique, Genève, studying Stephani types. She visited Portugal on her return journey and attended meetings there concerning the African flora.

RONALD L. MCGREGOR planned to leave in January for extensive field studies on *Riccia* in many parts of Mexico.

CHARLES D. BIRD a post-doctoral fellow at the Dept. of Botany, Uni-

versity of Alberta, Edmonton, Alta., has completed in mimeographed form "A preliminary annotated catalogue of the bryophyte flora of Alberta," copies of which are available from the author on request.

FREDERICK B. BEVIS has received a Sigma Xi grant of $350 to assist in the study of bryophyte and lichen micro-communities as indicators of site conditions in spruce-fir forests of the Lake Superior region.

Volume 63, Number 3 (pp. 137-202) was issued November 25, 1960.

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THE MOSS EXCHANGE

As announced in THE BRYOLOGIST **38**: 100, Sept.-Oct., 1935, there is now an exchange for mosses. This exchange is available to members of the American Bryological Society upon payment of annual dues of 25c to DR. RONALD A. PURSELL, School of Forestry, University of Pennsylvania, Mont Alto Branch, Mont Alto, Pa. Only fully identified specimens in packets with complete data on them should be sent in. It is suggested that there be five or more packets of each species.

These two exchanges offer an excellent opportunity for A.B.S. members to build up their own herbaria of choice, well-labelled specimens.